Surface Water Supply Options

Schlumberger Water Services

Draft Report

Prepared for The City of Lodi

CITY OF LODI
CALIFORNIA

September 2004

DRAFT
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By

Schlumberger
Water Services

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Flow Rate Conversions

		to get:	AF/yr	gpm	cfs	mgd
multiply	AF/yr	by:	1	0.6195	0.0014	0.0009
	gpm		1.614	1	0.0022	0.0014
	cfs		724.5	448.8	1	0.6463
	mgd		1121	694.4	1.547	1

Section 1. Executive Summary

This report looks at options for use of the surface water supply, assesses the use of recycled water from the City's White Slough Water Pollution control facility, and identifies possible mitigations for increased water demands for new developments.

Water Supply and Demand

Each year the City of Lodi water system delivers about 17,000 acre-feet of water from 24 active wells to approximately 17,000 customers serving about 60,000 people. Assuming growth within the City's sphere of influence maintains current densities, annual water demand at buildout would increase to about 22,000 acre-feet. This projection represents an average growth rate of one percent per year at a per capita use of 225 gallons per day, approximately 10 percent less than current rates. If growth were to occur at two percent with the current per capita use of 250 gallons per day, the 2040 population density for the City would be 70 percent greater than at present and annual water demand would be about 36,000 acre-feet per year. A demand of 22,000 acre-feet is used for this report as a reasonable estimate of buildout demand within the City's current sphere of influence and is the basis for evaluating alternatives.

In general, groundwater extractions in the City and surrounding area exceed natural replenishment and groundwater levels have been declining for many years. Projected growth will add approximately 5,000 acre-feet of demand on the aquifer system underlying the City. To reduce this dependence on groundwater, the City has approved a $48 million, 40-year contract to buy water from the Woodbridge Irrigation District (WID). The contract with WID will allow Lodi to use 6,000 acre-feet per year of WID surface water entitlement from the Mokelumne River at a nominal initial cost of $200 per acre-foot. The agreement increases the reliability of the City's water supply while allowing WID to pay for replacement of its 100-year-old Woodbridge Dam.

Water quality underlying the City is of very high quality, and is served to customers with minimal treatment. The most significant water quality concerns are DBCP, arsenic, TCE/PCE, and radon. Six of the City's wells are equipped with GAC treatment for removal of DBCP. Additional contaminants could be introduced through injection of surface water supplies, or through the mixing of treated surface water into the City's distribution system. Provisions have been made for protection of the water supply in the various alternatives considered in this report. Nonetheless, a detailed study of water quality, compatibility of surface and groundwaters, and treatment methods should be performed for any recharge project prior to implementation.

New Appropriations

There are several ongoing efforts in the region to obtain new surface water appropriations. The City of Lodi has varying degrees of involvement in each of these efforts, which include:

- the Mokelumne River Water and Power ("More Water") Project
- San Joaquin County/GBA diversion from the American/Sacramento Rivers
- the City of Stockton Delta Supply Project

The Mokelumne River Water and Power ("More Water") Project is being developed by a consortium of San Joaquin County agencies including Lodi. The project would involve a new diversion from the Mokelumne River and off-stream storage at the Duck Creek site. A water right application has been submitted. Preliminary engineering is to be completed by August 2004, and environmental documentation completed in 2005. Cost of this water supply has not yet been determined.

San Joaquin County has applied for a water right from the South Fork American River and has recently amended the application to allow diversion from the Sacramento River at the Freeport site. The County is working with San Joaquin County Groundwater Banking Authority, of which Lodi is a member, to develop this concept into a groundwater banking project. Cost to deliver this water to San Joaquin County would be about $290 per acre-foot, plus the cost of groundwater recharge facilities.

The City of Stockton Delta Supply Project would divert up to 125,900 acre-feet per year from the San Joaquin River in the Delta by 2050. A water right application was submitted in 1996 and environmental documentation is underway. The preferred option would convey water along Eight Mile Road to east of Interstate 5, approximately five miles from Lodi. Full diversion amounts are not expected to be available year-round, and groundwater banking in north Stockton is planned to bridge this shortfall. A preliminary estimate projects a unit cost of $350 per acre-foot of treated potable supply. The City of Stockton may be interested in purchasing a portion of the Lodi WID water as an interim supply until the project is permitted and constructed. Lodi might participate in development of regional groundwater recharge facilities.

The City should continue its involvement in and monitoring of the More Water and GBA/Freeport projects. It is recommended that the City continue discussions and negotiations with the City of Stockton for both short-term and long-term joint water recharge options using the WID supply.

Surface Water Supply Options

Surface water supply options were evaluated to determine the most cost effective sources of supply and how to effectively put those sources to use. Surface water supply options examined include direct surface water treatment and distribution to customers, groundwater injection wells, pond recharge, direct supply for irrigation use, and regional groundwater banking projects.

Among the City-only alternatives, and excluding the cost of the WID water purchase, the most cost-effective means of using the WID supply is through percolation ponds in close proximity to the WID South Canal (average recharge cost of $100/AF for operations and capital repayment). Recharging groundwater on the eastern side of town either from the WID canal or through the North San Joaquin Water Conservation District system is the next least expensive option ($160/AF), offering the best opportunity for recharge upgradient of City wells. Using the WID supply to irrigate parks and schools is also a reasonable option ($180/AF), but would be limited to about 1000 acre-feet per year. Use of injection wells, while feasible, would require a widely dispersed system increasing the cost of the alternative ($280/AF).

Constructing a surface water treatment plant would allow the WID supply to be served to City customers in lieu of groundwater pumping. The surface water treatment plant is two to three times more expensive than pond recharge alternatives ($320/AF) and would require additional facilities to chlorinate the entire City distribution system.

Regional projects with the City of Stockton or the East Bay Municipal Utility District on either an interim or long-term basis has the potential for mutual benefit. It may be possible to negotiate agreements that would fully offset Lodi's costs ($0/AF) for a water supply project. An interim agreement for an in-river transfer of the WID-purchase water to EBMUD has the potential for mutual benefit to both parties – by providing interim cost offsets to Lodi's WID purchase, and supplying EBMUD with a drought contingency supply until its Freeport project is completed. Negotiations with EBMUD should be restarted on both the interim in-river exchange option, and long-term water banking arrangements. Negotiations with the City of Stockton should be considered.

It is recommended that percolation tests be conducted for a period of several months at both the proposed Westside and Eastside recharge pond sites to establish feasibility of long-term percolation.

It is further recommended that well pump tests be conducted on wells of known construction in the southern and eastern portions of the City to provide refined estimates of aquifer parameters used in the injection well feasibility analysis. At least two of these wells should be temporarily converted to injection wells for pilot testing.

Recycled Water Options

The recycled water section of this report provides a framework for future decision-making regarding recycling options for tertiary treated effluent within the City's service area. Recycling options available to the City are reviewed along with the potential pathways for financial support associated with capital improvements and the current water quality regulations for recycled water projects. Use of recycled water is moderately to greatly more expensive than surface water recharge projects, but may provide offsetting benefits as regulatory requirements become more restrictive.

Facilities to pump tertiary-treated wastewater from the White Slough Water Pollution Control Facility for application on irrigated areas within the City would cost about $240 per acre-foot. Building in-City tertiary treatment facilities would obviate the need for a pump-back pipeline, but would be significantly more expensive ($920/AF). These estimates exclude the cost of a new non-potable distribution system and regulating storage. Costs for the non-potable distribution system to serve new development might be reasonably required as a fee to mitigate increased water demand.

Recycled water projects are not cost-competitive with other options available to the City using the WID supply. However, grant funding for study and construction of recycled water projects under Proposition 50 will soon be available and could make Lodi's use of recycled water viable. The City should monitor and apply for grant money when it becomes available. The City staff should also evaluate cost-saving offsets of reduced White Slough operation, delay of planned White Slough expansions, and plant upgrades required by reasonably foreseeable regulatory changes.

A summary of the cost of the water recharge options is presented in Table 1. Unit recharge costs range from $100 per acre-foot for the Westside recharge pond to $320[1] per acre-foot for

[1] Additional costs for chlorination of City distribution system would be necessary.

a surface water treatment plant. Facilities to pump tertiary-treated wastewater from the White Slough Water Pollution Control Facility for application on irrigated areas within the City would cost about $240 per acre-foot. Building in-City tertiary treatment facilities would obviate the need for a pump-back pipeline, but would be significantly more expensive. These costs exclude the cost of a new non-potable distribution system and regulating storage. Costs for the non-potable distribution system to serve new development might be reasonably required as a fee to mitigate increased water demand.

As context, cost to supply water to San Joaquin County through the planned Freeport Project facilities could cost as much as $290 per acre-foot plus the cost of groundwater recharge facilities, and the planned City of Stockton's Delta Water Supply Project is projected to produce potable water at $350 per acre-foot.

Mitigations for New Development

New developments will add additional demand on the City's water resources and require construction of additional facilities to accommodate this demand. The developer mitigation section reviews the practices of northern California municipal utilities that impose development mitigation requirements and compiles a list of potential requirements that the City could reasonably enforce to mitigate increased water demand.

As a result of studying various urban water management plans, several potential mitigations can be proposed for new developments in the City of Lodi. In summary, these mitigations are:

- Water use efficiency programs and metering
    - Meter water usage and charge by volume
    - Submetering of apartments, condominiums, and trailer parks
    - Establishing an inclining block rate structure
    - Require automatic irrigation systems in new development
    - Charge developer a water meter installation fee
    - Provide detailed and educational billing statements
    - Fund water meter retrofit programs for older homes
- Funding and construction of water supply infrastructure
    - Charge a connection charge tied to the cost of the existing supply and distribution system
    - Charge fees that cover new water production and transmission facilities and infrastructure including surface water fee tied to the cost of acquiring and developing the new supply, or alternately, require developer construction of such facilities that serve a single development or limited geographic area

- Reclamation and dual plumbing requirements
    - Require dual distribution systems with dual connections to allow for reclaimed water landscape irrigation in public and common areas
    - Provide incentives for reclaimed water or grey water landscaping at private facilities
    - Require funding of in-city wastewater treatment plants to be used for reclaimed water supply
    - Require use of reclaimed water for construction and dust control uses
- Building code and landscaping requirements
    - Require automatic irrigation systems for new single-family homes
    - Provide incentives for drought-tolerant landscaping
    - Require the installation of low-flow water user fixtures in residential and commercial developments
    - Provide incentives for water-efficient appliances
    - Provide incentives for xeriscape landscaping

Table 1: Summary of Alternatives

Project Category	Alternative	Average Water Supply (AF/year)	Estimated City Capital Cost	Estimated O&M Cost	Annualized Cost[1]	Unit Cost in $/AF of Avg. Use	Comments
Surface Water Projects with City Cost	Surface Water Irrigation of Parks and Schools	1,000	$1,400,000	$68,000	$180,000	$180	Does not maximize use of WID supply
	Injection Wells	6,000	$14,600,000	$520,000	$1,660,000	$280	Small amount of surface area required; provides direct recharge; high operation and maintenance costs; requires dispersed network of injection and extraction wells
	Westside Recharge Pond	6,000	$6,000,000	$112,000	$580,000	$100	Most economical; land available; suitable infiltration rates
	Eastside Recharge Pond	6,000	$9,400,000	$191,000	$930,000	$160	Recharge located in area of lowest GW levels; land available; suitable infiltration rates
	Surface Water Treatment Plant	6,000	$13,900,000	$800,000	$1,890,000	$320	Provides in-lieu groundwater recharge; disinfection of entire distribution system required; needs base line supply
	Recharge Utilizing NSJWCD Facilities	6,000	$10,400,000	$150,000	$960,000	$160	Recharge located in area of lowest groundwater levels; land available; additional capacity using NSJWCD supply
Regional Projects with Shared or No City Cost[2]	Stockton Interim Recharge Ponds	6,000	$0 to $10,800,000	$0 to $110,000	$0 to $950,000	$0 to $160	Interim project to offset WID purchase costs; use of flood control facilities could reduce cost
	EBMUD In-Lieu and Banking Potential	6,000	$0 to $31,600,000	$0 to $1,300,000	$0 to $3,770,000	$0 to $630	Recharge located in area of lowest GW levels: cost sharing opportunities; water export may be controversial
	EBMUD In-River Exchange	0 [5]	$0	$0	$0	net revenue generator	Interim revenue generation option. Average supply to EBMUD 1,000 AF/yr, leaving 5,000 AF/yr for local recharge
Recycled Water Projects with City Cost	White Slough Recycled Water Return[3]	2,000	$4,700,000	$98,000	$470,000	$240	No new cost for water; funding assistance may be available; public perception issues;
	Scalping Facility[3,4]	2,000	$14,600,000	$700,000	$1,840,000	$920	No new cost for water; funding assistance may be available; public perception issues

[1] Capital repayment based on a 25-year payback period with 6% interest; Table does not include the price of water
[2] Range of costs reflects to-be-negotiated cost sharing
[3] Excludes non-potable distribution system and regulating storage
[4] Excludes offsetting benefit of operation delayed expansion of White Slough WPCF
[5] 3,000 AF of WID supply transferred to EBMUD in 1/3 of years

Section 2. Introduction

Background

The City of Lodi Water Utility system incorporates 24 active wells, over 207 miles of water transmission mains, a water tower, and a one million gallon storage tank. [2] The current water supply for the City is pumped entirely from local groundwater. The City delivers water to approximately 17,000 residential, commercial, and industrial customers serving approximately 60,000 people. In 2001, 16,700 acre-feet of water was pumped to meet water demands. In general, groundwater extractions in the City and surrounding area exceed natural replenishment and groundwater levels have been declining for many years.

Wells located throughout the service area deliver water directly to the distribution system. This supply is delivered untreated, except in certain areas and at certain times. Six wells are equipped with activated carbon water treatment units, and two have ultraviolet contactors. The typical capacity of a new water supply well is about 1,600 gallons per minute (gpm). Approximate well locations along with average production rates of each well are shown in Figure 1.

A Water Master Plan was prepared in 1962 to design the water system to meet future City needs. The plan was updated in 1977 and 1990[3]. The City's 1991 General Plan[4] provides land use, zoning and population figures. Identified issues in the General Plan include water quality, groundwater basin overdraft, and the "Central Area restriction."

To reduce its dependence on groundwater, the City recently approved a $48 million, 40-year contract to buy water from the Woodbridge Irrigation District (WID). The contract with WID will allow Lodi to use 6,000 acre-feet per year of WID surface water entitlement from the Mokelumne River at a nominal initial cost of $200 per acre-foot[5]. The agreement increases the reliability of the City's water supply while allowing WID to pay to replace Woodbridge Dam. This new dam will replace the existing structure, which is over 100 years old and allow Lodi Lake to be full all year long. The existing dam is equipped with flash boards which must be removed to allow potential Mokelumne River storm flows in the Mokelumne River to pass unimpeded during winter months, thus draining Lodi Lake each winter.

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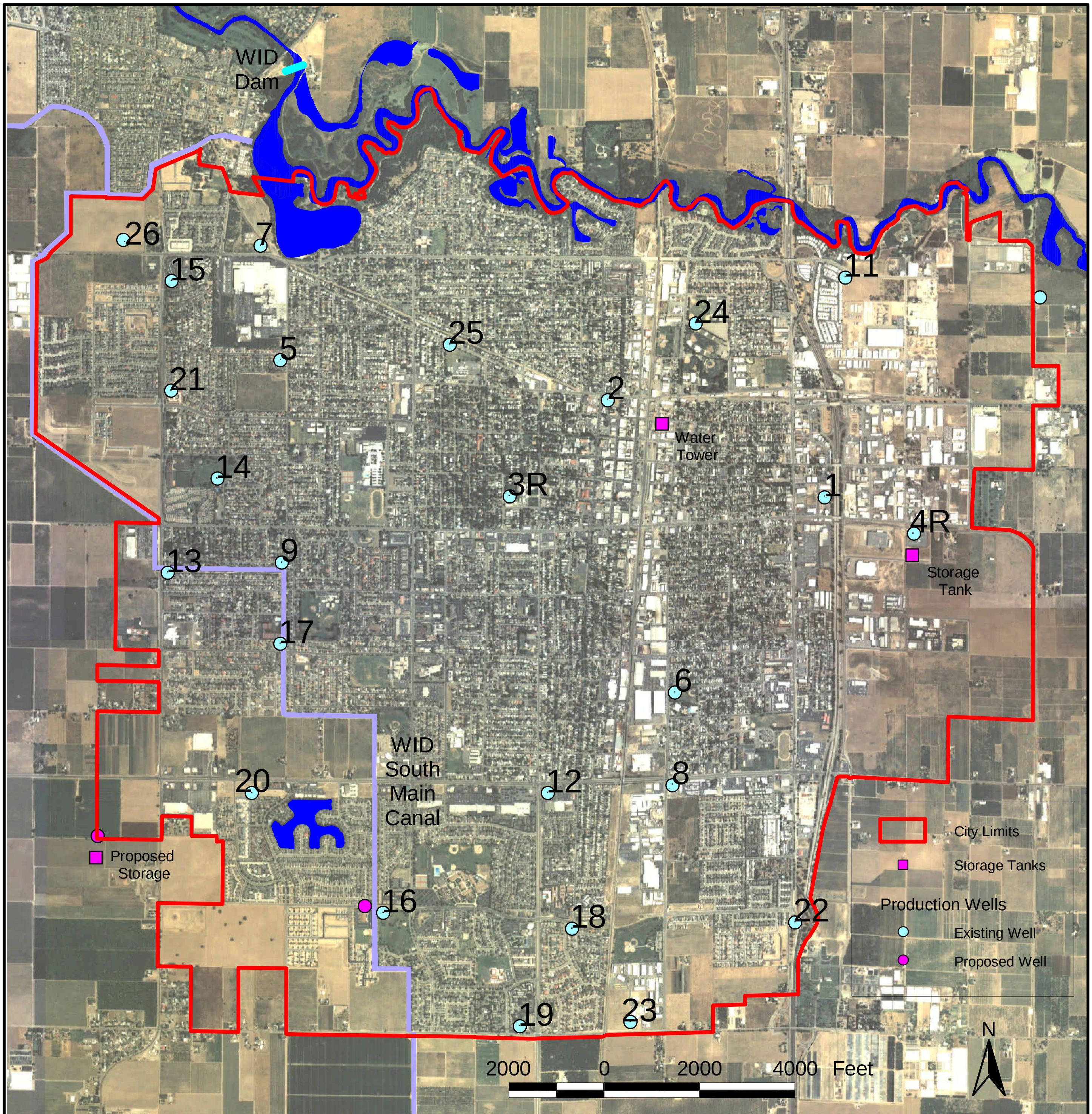
[2] http://www.lodi.gov
[3] Psomas, 1990, City of Lodi Water Master Plan
[4] Jones and Stokes Associates, 1991, City of Lodi General Plan
[5] Additional provisions of this agreement are presented in Chapter 3, "WID Purchase Agreement"



Well Number	1R	2	3R	4R	5	6R	7	8	9	11R	12	13	14
Average Flow (gpm)	1,100	700	800	2,100	1,200	1,400	1,100	800	1,000	1,300	800	1,100	1,600

Well Number	15	16	17	18	19	20	21	22	23	24	25	26	Total
Average Flow (gpm)	1,600	1,000	1,800	1,800	1,100	2,000	2,000	1,400	1,500	1,400	1,600	1,400	33.8K

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Production Wells With Average Flow Rates

City of Lodi
Surface Water Supply Options

Figure 1

Date: October 2003

Prepared By: BCW

Purpose of Report

The City of Lodi is proactively addressing water supply alternatives to ensure a sustainable source for its current and future water demands. SKS was retained by the City to address three main water supply issues, presented in this report:

1. Assess options for use of surface water supply.
2. Assess feasibility of using recycled water from the White Slough Water Pollution Control Facility (WPCF).
3. Identify mitigations for increased water demand from new developments.

Surface water supply options were evaluated to determine the most cost effective sources of supply and how to effectively put those sources to use. Surface water supply options examined include direct surface water treatment and distribution to customers, groundwater injection wells, pond recharge, direct supply for irrigation use, and regional groundwater banking projects.

The recycled water section of this report provides a framework for future decision-making regarding recycling options for tertiary treated effluent within the City's service area. Recycling options available to the City are reviewed along with the potential pathways for financial support associated with capital improvements and the current water quality regulations for recycled water projects.

New developments will add additional demand on the City's water resources and require construction of additional facilities to accommodate this demand. The developer mitigation section reviews the practices of northern California municipal utilities that impose development mitigation requirements and compiles a list of potential requirements that the City could reasonably enforce to mitigate increased water demand.

Section 3. Water Supply and Demand Characterization

Historical and Projected Population

Historical population figures received from the City for the years 1970 to 2002 are summarized in Table 2. The population of Lodi grew at an average rate of 2.8% per year between 1970 and 1987. Since 1987 the City has limited all growth to two percent annually by controlling the allocation of building permits. Growth from 1987 through 2003 has averaged 1.9% per year.

To estimate future population growth this study assumes a low and high estimate of 1% and 2% growth per year through 2040. At 1% growth, the 2040 population would reach 86,300 or about a 50% increase. At 2% annual growth the 2040 population would reach 127,900. Table 3 compares historical population and density to the population projections for 2040. The area of the City is taken from various sources. The buildout area of the City is assumed to be 8,990 acres as stated in 1991 General Plan.

Table 2: Historical Population and Water Demand

Year	Population [a]	Population Increase	Water use in AF/Year [a, b]	Gallons per person per day
1970	28,614		11,462	358
1971	29,307	2.42%	12,303	375
1972	29,990	2.33%	11,686	348
1973	30,650	2.20%	12,205	355
1974	30,960	1.01%	12,002	346
1975	31,350	1.26%	12,294	350
1976	32,150	2.55%	13,607	378
1977	32,250	0.31%	10,578	293
1978	32,932	2.11%	11,478	311
1979	33,356	1.29%	12,349	331
1980	34,400	3.13%	12,312	320
1981	35,450	3.05%	12,487	314
1982	36,928	4.17%	11,560	279
1983	38,318	3.76%	11,539	269
1984	39,679	3.55%	13,997	315
1985	41,323	4.14%	14,814	320
1986	43,293	4.77%	15,081	311
1987	45,795	5.78%	15,305	298
1988	48,042	4.91%	15,360	285
1989	49,221	2.45%	14,654	266
1990	50,328	2.25%	15,387	273
1991	52,539	4.39%	13,313	226
1992	53,186	1.23%	13,985	235
1993	53,293	0.20%	14,013	235
1994	53,903	1.14%	14,301	237
1995	54,000	0.18%	14,390	238
1996	54,473	0.88%	15,102	248
1997	54,700	0.42%	16,330	267
1998	55,681	1.79%	14,461	232
1999	56,926	2.24%	16,587	260
2000	57,935	1.77%	16,722	258
2001	58,600	1.15%	17,106	261
2002	58,600	1.42%	16,640	250
2003	60,521	1.83%	16,185	239

[a] Data received from the City of Lodi.
[b] Total water production for system (all residential, industrial, commercial, landscape, etc.)

Table 3: Population Density

Year	Population	City Area (acres)	Density (persons/ acre)
1987	45,794	4,998[a]	9.2
2002	59,431	7,066[b]	8.4
2040 - Low (1% Annual Growth)	86,300	8,990[c]	9.6
2040 - High (2% Annual Growth)	127,900	8,990[c]	14.2

[a] 1987 acreage from 1988 General Plan

[b] 2002 acreage from personal communication w/Eric Viercamp, City Planning Dept, 4/25/03

c Buildout acreage from 1991 General Plan including Reserve Area

As shown in Table 3, an average annual population growth of 1% would generate a population density of 9.6 persons per acre in 2040. An average annual population growth of 2% would generate a population density of 14.2 persons per acre in 2040, a 70% increase in density over current levels. Given the historical population density of 8.4 to 9.2 persons per acre, it seems more reasonable to assume annual City growth will average 1% over the next 40 years, even though buildout may be reached sooner. This assumes that the total area designated for buildout does not increase during the next 40 years.

Historical and Projected Water Demand

City water demand from 1970 through 2000 is reported in the 2001 Urban Water Management Plan (UWMP). Water demand grew at a slower rate relative to population with an average increase in demand of 1.3% from 1970 to 2000. As illustrated in Figure 2, residential demand dominates City water use, amounting to approximately 72 percent of City water demands.[6]

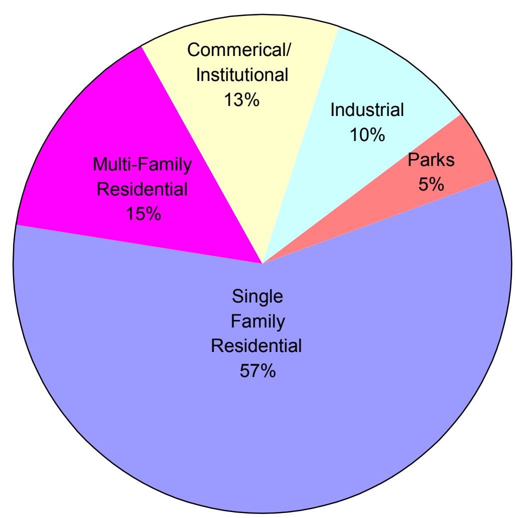

Figure 2: Demand by Sector

Dividing the total water demand by the population, without correction for changes in commercial and industrial uses, results in the gross per capita demand presented in Table 2. This table shows a steady decreasing trend in per capita use from 358 gallons per capita day (gpcd) in 1970 to 239 gpcd in 2003.

[6] 11/23/98 memorandum to Lodi City Council, "Water Supply Master Plan"

For this study, the current 2002 demand of 250 gpcd was assumed as the high estimate of future demand. However with continued aggressive implementation of conservation practices, a reduction of an additional 10% in water demand may be possible. A 10% reduction of the 2002 unit use to 225 gpcd is assumed for a low estimate of future per capita demand.

Table 4 displays historical and projected (1990 and 2020) per capita water use for the Lodi and water suppliers located near Lodi[7]. The per capita use rates for water suppliers near the City are taken from DWR Bulletin 160-98. The 2020 forecast is a product of model runs reflecting the implementation of water conservation measures and socioeconomic change. As shown in Table 4, the projected average decrease in water use is roughly 11% between 1990 and 2020 for water suppliers near the City. Stockton, EBMUD, and Davis are fully metered. Lodi, Fresno, Sacramento, and Modesto are unmetered. Approximately 22% of Merced is metered.[8] The average per capita water use from 1988-1992 is presented in Table 4 as the 1990 water use for the City to account for variations in hydrology. As shown in Table 4, a 225 gpcd for the City in 2020 would represent a 12.5% reduction from average 1990 numbers.

Table 4: Per Capita Water Demand

	1990 gpcd	2020 gpcd	Percent Change
Cal Water,Stockton[a]	187	162	-13.4%
EBMUD[1]	196	171	-12.8%
City of Davis[c]	230	185	-20.0%
City of Fresno[a]	285	262	-8.1%
City of Sacramento[a]	290	263	-9.3%
City of Modesto[d]	289	289	0.0%
City of Merced[a]	336	299	-11.0%
Average			-10.7%
Lodi	257[2]	225	-12.5%

[a] DWR Bulletin 160-98, p.4-15

[b] Average of 1988 to 1992 per capita water use taken from historical data to account for variations in hydrology

[c] The California Aggie, 5/7/04

[d] Modesto 2000 Urban Water Management Plan. 1995 per capita use assumed in UWMP projection. Residential uses taken alone are reported to average 170 gpcd.

These assumed growth and per capita use rates result in the demand projections shown in Figure 3. The low demand projection for 2040 estimates an average annual water demand of 21,700 acre-feet, using a 1% population growth rate and a 10% reduction in current per capita water use. The high demand projection for 2040 estimates an average annual water demand of 35,800 acre-feet, using a 2% population growth rate and 2002 per capita water use.

[7] City of Manteca reports a 2002 consumption rate of 217 gpcd, and is fully metered (http://www.ci.manteca.ca.us/eng/water/facts.html)

[8] 1999 data from http://water-energy.lbl.gov/pubs/CaliforniaWaterMeters.pdf

The 1991 Lodi General Plan adopted a buildout water demand of 33,000 acre-feet per year (31.4 mgd) and a build-out population of 96,721 (304 gpcd). 2007 demand was projected as 26,900 acre-feet per year (24.0 mgd) serving a population of 71,665 (335 gpcd).

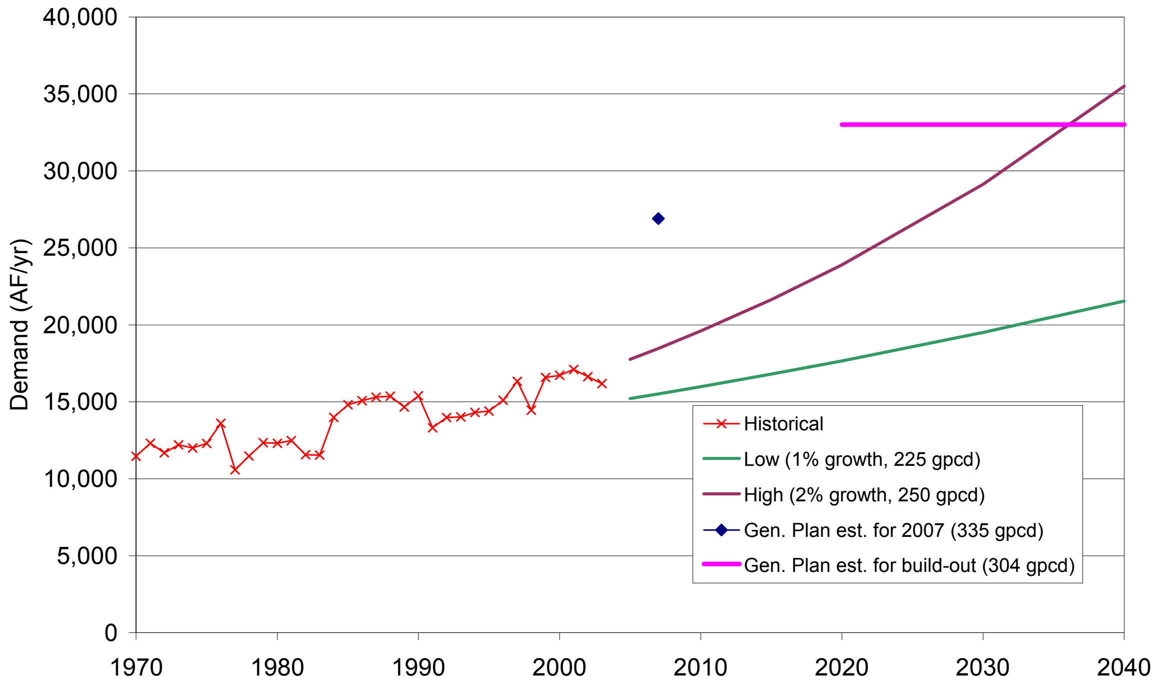

Figure 3: Historical and Projected Water Demand

Conservation Programs

The City's water conservation program was started in 1977 in the midst of a severe two-year drought. A pilot meter installation program was initiated that same year. The non-residential retrofit program was discontinued in 1994. The City's conservation efforts include yard watering restrictions and enforcement, in-school education programs, public information and education programs, distribution of water conservation kits, and building code enforcement.[9]

The City Public Works and Electric Utility Departments sponsor a Residential and Commercial Water Conservation Rebate Program, which will provide up to $44 of the cost of retrofitting older toilets with a modern Ultra Low-Flow Toilet (ULFT) or up to $100 for installation of a pressure-assisted ULFT. Additional rebates of 50 percent are offered for installation of low-flow shower heads, insulated hot water blankets, and hose bib manual timers through local hardware distributors.

[9] Handout material from City of Lodi 7/26/98 public water workshop

Aquifer System

The City of Lodi overlies the Eastern San Joaquin Groundwater Basin, which is an integral, interconnected part of the Central Valley Groundwater Basin. As defined in DWR Bulletin 118-80, the Eastern San Joaquin Groundwater Basin is bounded by the San Joaquin and Stanislaus rivers to the west and south, the Calaveras County line along the foothills to the east, and Dry Creek to the north. Figure 4 displays the location of the Eastern San Joaquin Groundwater Basin in relation to the City.

The 1985 Eastern San Joaquin County Groundwater Study[10] concluded that the supply of fresh groundwater in the basin is contained in the Mehrten formation and overlying younger aquifer units. The upper aquifer is considered unconfined to semi-confined in the central part of San Joaquin County. Groundwater contour maps suggest the aquifer underlying Lodi is largely unconfined.

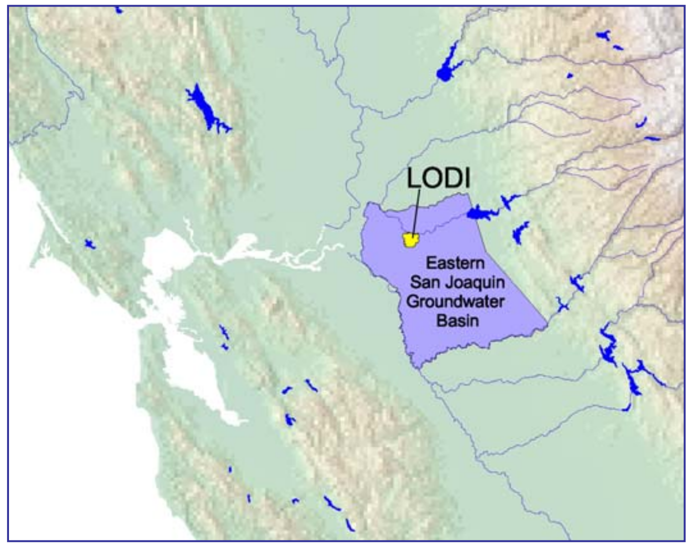

Figure 4: Eastern San Joaquin Groundwater Basin

San Joaquin Groundwater Basin Overdraft

DWR Bulletin 118-80 characterizes the Eastern San Joaquin County Groundwater Basin as “subject to conditions of critical overdraft” and estimates a supplemental supply of 77,000 AF/yr is required to balance inflow and outflow.

DWR studied eastern San Joaquin County as a part of the Stanislaus-Calaveras conjunctive use project in 1997. This study suggested that the annual overdraft in the eastern County was about 70,000 acre-feet per year at 1990 levels of development. A later study completed by the U.S. Bureau of Reclamation as part of the American River Water Resource Investigation estimated overdraft at 130,000 acre-feet per year at a 2030 level of development.

[10] Brown and Caldwell, 1985

The 1998 DWR California Water Plan Update[11] characterizes the long history of overdraft and declining groundwater levels in Eastern San Joaquin County. Groundwater extraction to meet agricultural and urban demands has created two pronounced pumping depressions since the late 1940s and early 1950s. The larger depression is between the Mokelumne and Stanislaus Rivers. The center of this depression is east of Stockton, where groundwater levels can be more than 70 feet below sea level following the irrigation season. The other groundwater depression is between the Cosumnes and Mokelumne rivers, extending north into Sacramento County. Groundwater levels here are more than 30 feet below sea level.

While not currently an issue in Lodi, the pumping depressions described have allowed for easterly migration of poor quality saline water underlying the Delta into western Stockton. Several municipal wells in west Stockton have been abandoned because of the decline in groundwater quality due to saline water migration.

Saline water at a concentration of 300 ppm of chloride has been mapped in west and southwest Stockton from the Stockton Ship Channel to the County hospital and as far east as Airport Way (approximately halfway between Interstate 5 and State Highway 99). Chloride concentrations above 300 parts per million (ppm) are generally not suitable for most drinking water and irrigation uses. The 2001 San Joaquin County Water Management Plan[12] reiterates these findings describing the link between groundwater pumping in the east county region and the easterly migration of poor quality water underlying the Delta.

Groundwater Within City Limits

Historical groundwater levels measured within the City's service area indicate that the more groundwater is extracted annually than is replenished. The *2001* UWMP notes an average annual decrease in groundwater levels from 1927 to 2000 of 0.35 feet per year within the City. Figure 5 displays the average annual standing water elevation at municipal supply Well No. 2 from 1962 to 2002. As shown in Figure 5, the average annual groundwater level fluctuates dependant upon variations in recharge, but the long-term trend has shown a general decline in groundwater levels.

Figures 6 through 8 display groundwater contours of equal elevation relative to mean sea level (MSL) for the years 1964, 1983, and 2002. The average ground surface elevation of Lodi is approximately 51 feet above MSL. Average annual standing water elevations of

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[11] California Department of Water Resources, November 1998, The California Water Plan Update, Bulletin 160-98

[12] Camp Dresser & McKee, October 2001, San Joaquin Count Flood Control and Water Conservation District, Water Management Plan Phase 1 – Planning Analysis and Strategy.

municipal supply wells were used to develop the elevation contours for the aforementioned years. As shown in the three figures, groundwater elevations have declined between 10 and 15 feet throughout the City from 1964 to 2002. Depth to groundwater ranges between 30 and 75 feet. The shallowest groundwater is found in the northern portion of the City near the Mokelumne River.

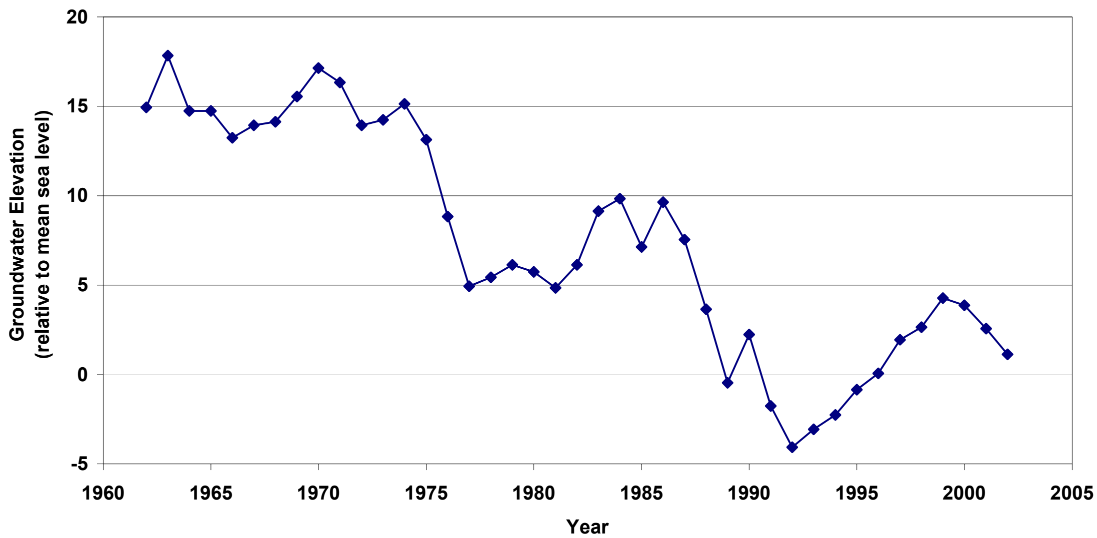
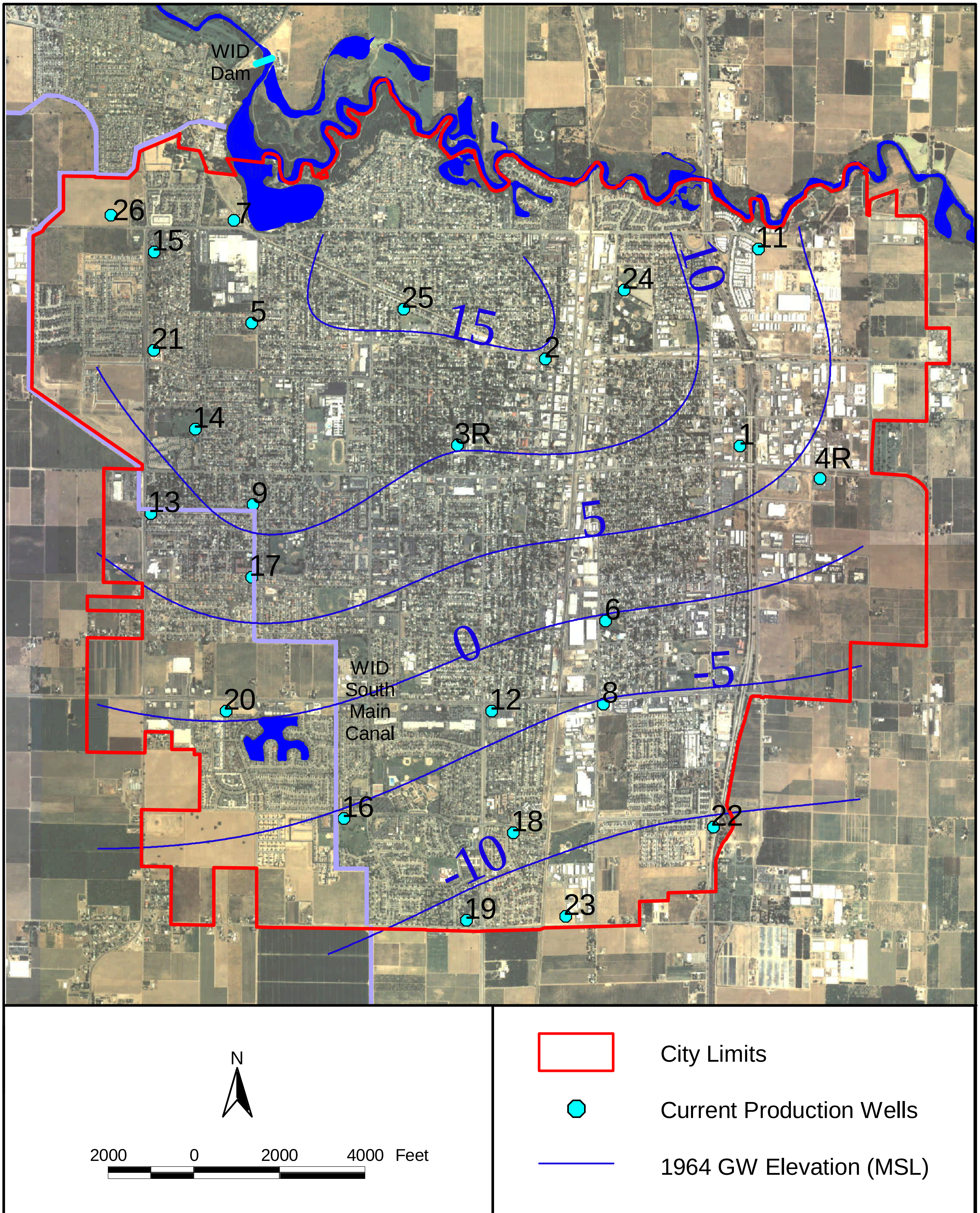


Figure 5: Average Standing Water Elevation for Well No. 2 (1962-2002)

The declining groundwater levels within the City service area indicate that the sustainable groundwater extraction rate is less than current annual pumping rates. To date, the safe yield of the groundwater basin underlying the City has not been determined. The 2001 UWMP estimated sustainable groundwater pumping at 12,000 AF/yr, approximately equivalent to the pumping rate in 1980.

Quantifying safe yield of a basin is inherently complex and is beyond the scope of this study. Conservative estimates of safe yield on a unit area basis for the region are typically on the order of one acre-foot of water extracted per acre per year. The current sphere of influence for the City is approximately 8,990 acres, which would give a conservative estimate of safe yield of roughly 9,000 acre-feet per year. Given the close proximity of the Mokelumne River to Lodi, the safe yield of the City's service area is probably slightly higher than this estimate. But given the decline in groundwater elevation over the past two decades the safe yield is likely less than the previous 20-year extraction rates of 14,000 acre-feet or more.



Saracino·Kirby·Snow
A Schlumberger Company

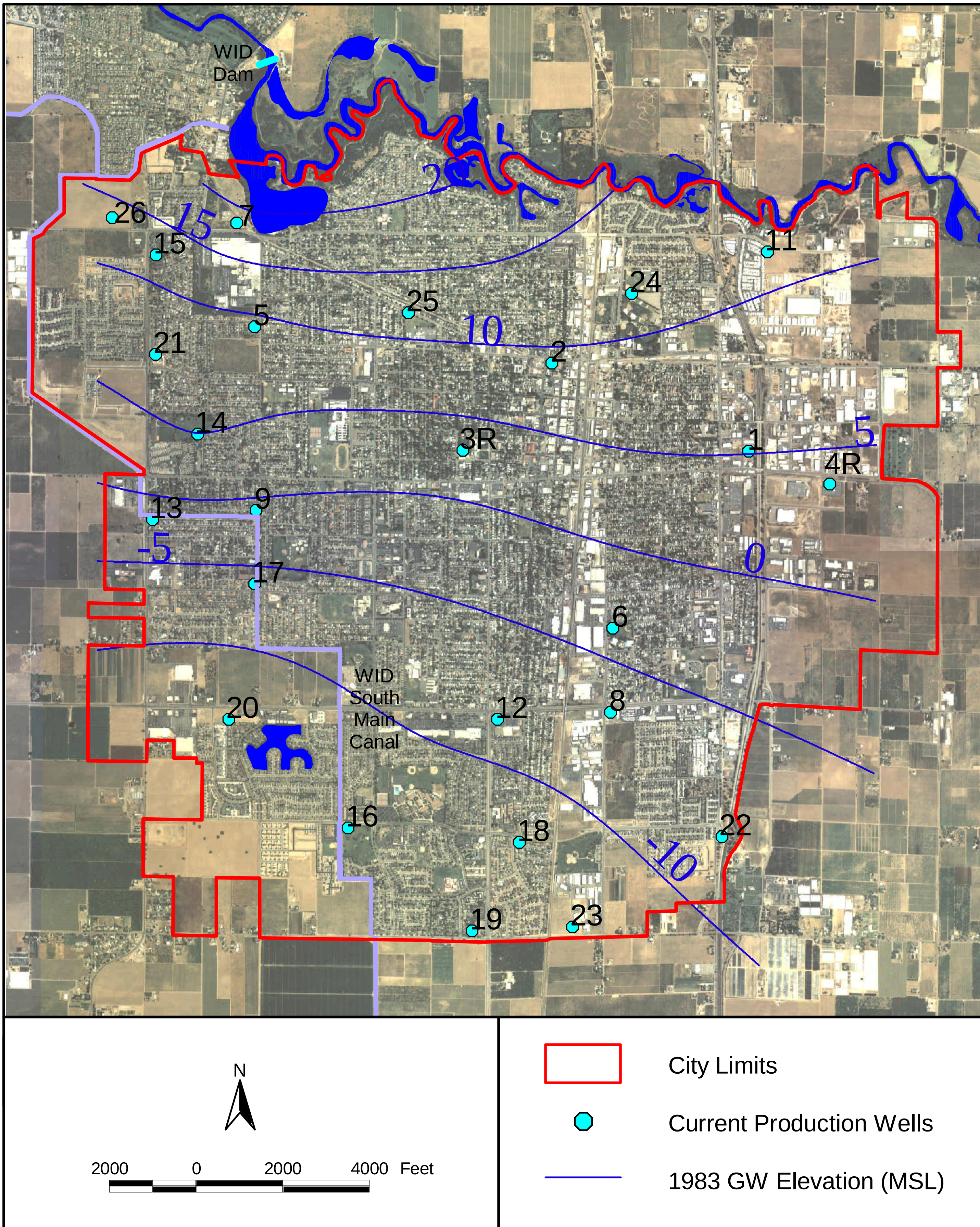
1964 Groundwater Elevations (Feet) Relative to MSL

City of Lodi
Surface Water Supply Options

Figure 6

Date: October 2003

Prepared By: BCW



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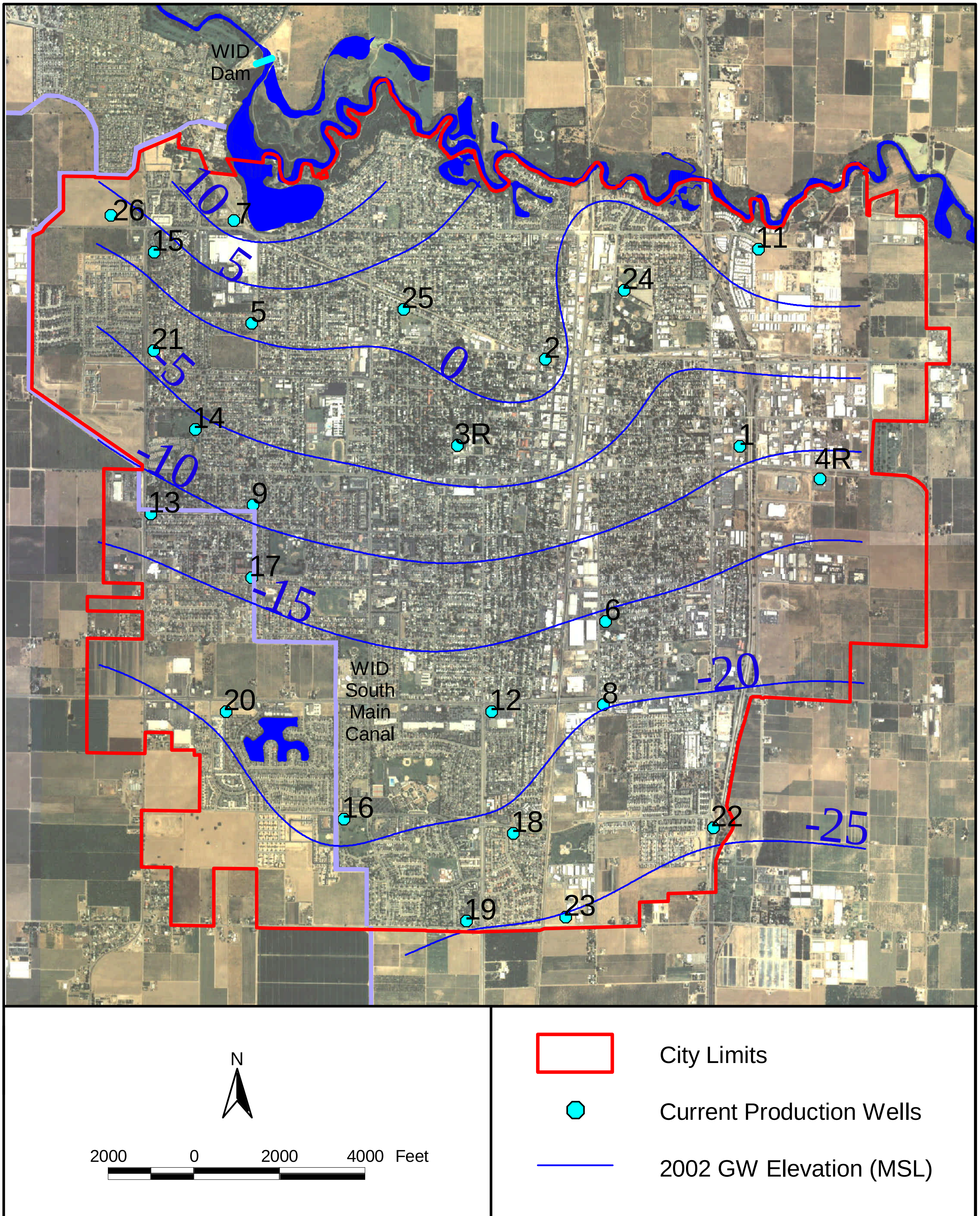
1983 Groundwater Elevations (Feet) Relative to MSL

City of Lodi
Surface Water Supply Options

Figure 7

Date: October 2003

Prepared By: BCW



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2002 Groundwater Elevations (Feet)
Relative to MSL

City of Lodi
Surface Water Supply Options

Figure 8

Date: October 2003

Prepared By: BCW

Groundwater Quality

The most significant water quality concerns in the City's service area is DBCP (dibromochloropropane), arsenic, TCE/PCE, and radon.

DBCP (dibromochloropropane)

Six of the City's municipal supply wells are equipped with granular activated carbon (GAC) treatment systems for removal of DBCP (dibromochloropropane). The pesticide DBCP was used in vineyards up until 1979 for nematode control, and is extremely persistent in groundwater. DBCP has contaminated tap water in 38 water systems in nine counties. Lodi, Fresno, Riverside, Clovis, and Madera are the largest communities with a serious problem. DBCP has been shown to cause cancer in lab animals when exposed to very high levels over their lifetimes.

The U.S. EPA and State of California drinking water standard for DBCP has been set at 0.2 parts per billion (ppb). Drinking water standards are set to include a safety factor for the general population and take into account the cost and practicality of removing the particular contaminant. Lodi water served through the distribution system is below the DBCP level deemed safe by the U.S. EPA and the State of California.[13] In 1996 the City settled a lawsuit against DBCP manufacturers, who have paid and will continue to pay a large portion of Lodi's costs related to DBCP treatment over a 40-year settlement.

Arsenic

Arsenic is a mineral known to cause cancer in humans at high concentrations and is linked to other health effects such as skin damage and circulatory problems. The EPA is currently lowering the drinking water standard for arsenic from 50 ppb to 10 ppb. The average in Lodi's wells is 3.5 ppb and the highest well is 7.7 ppb.

TCE/PCE (Trichloroethylene/Perchloroethylene)

Low concentrations of the chemicals TCE and PCE (trichloroethylene and perchloroethylene) have been found in Lodi groundwater, mainly in the downtown area bounded by Mills Avenue, Kettleman Lane, and Highway 99. The MCL for PCE and TCE in drinking water is 5 ppb. The average concentration of Lodi wells in 2002 was 0.04 and 0.12 ppb for PCE and TCE, respectively. The source of these chemicals is thought to be

[13] http://www.lodi.gov

discharges from dry cleaning and other industrial businesses. The City is pursuing a resolution to the contamination problem and continues to retain legal and engineering assistance for future remediation efforts.

PCE is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal-degreasing. TCE is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers.

Radon

Radon is a radioactive byproduct of uranium that occurs naturally in groundwater. It has a short half-life of just 3.8 days, and readily volatizes when exposed to air. Breathing radon in the indoor air of homes is the primary public health risk from radon. The 1996 Safe Drinking Water Act Amendments required EPA to establish several new, health-based drinking water regulations, including a multimedia approach to address the public health risks from radon.

States can choose to develop enhanced programs to address the health risks from radon in indoor air -- known as Multimedia Mitigation (MMM) programs – in conjunction with water systems reducing radon levels in drinking water to 4,000 pCi/L (picoCuries per liter, a standard unit of radiation) or lower. EPA is encouraging states to adopt this option because it is the most cost-effective way to achieve the greatest radon risk reduction.

If a state chooses not to develop an MMM program, individual water systems in that state would be required to either reduce radon in their system's drinking water to 300 pCi/L or develop individual local MMM programs and reduce levels in drinking water to 4,000 pCi/L. Water systems already at or below 300 pCi/L standard would not be required to treat their water for radon. In 2002, the City's wells averaged 378 pCi/L and range from 268-568.[14]

Lodi Decree

When EBMUD was planning and constructing Pardee Dam in the 1920s, there was considerable concern in Lodi that the dam would interfere with the seepage from the natural flow of the Mokelumne River that replenished the City's water supply. In January 1929, Lodi filed suit in San Joaquin Superior Court to enjoin EBMUD from diverting water from the Mokelumne. The case, *Lodi v. EBMUD et al.* reached the state Supreme Court and was ultimately settled in March 1938. The court-approved negotiated settlement, known as the Lodi Decree, provided that if EBMUD operations caused water levels in a six-square mile area (adjacent to the Mokelumne River in central Lodi) to drop below sea level in two

[14] City of Lodi Annual Water Quality Report for 2002

consecutive Januarys and the City is unable to pump 3,600 acre-feet from this area, EBMUD would supply the City with any deficiency up to 3,600 acre-feet per year. This condition has never been triggered.

Woodbridge Irrigation District Water Rights

Woodbridge Irrigation District (WID) provides irrigation water to a net area of 19,370 acres within a gross area of 40,442 acres, including portions of western Lodi[15]. WID takes delivery of its water through a set of gates located near the southwest corner of Lodi Lake, an impoundment created by Woodbridge Dam on the Mokelumne River. WID also pumps relatively small quantities of water from Beaver Slough, a tidal arm of the South Mokelumne River in the northwest portion of the district.

(Old) Woodbridge Dam

There are approximately 90 miles of canals and laterals in the Woodbridge System. Only about 20 percent are concrete lined. The 72 miles of unlined canals lose significant amounts of water and are an important source of local groundwater recharge. In 1991 J.M. Lord Incorporated[16] conducted seepage tests of approximately 11,000 feet of WID laterals, including:

- Thompson lateral, three miles northwest of Woodbridge Dam;
- Spenker-Jones lateral, two miles west of Woodbridge Dam, and;
- State Farm lateral, seven miles south of Kettleman Lane.

Measured canal losses ranged from 0.89 to 3.49 acre-feet per day per mile, and averaged 2.48 acre-feet per day per mile. The study concluded that total WID losses could be more than 24,000 acre-feet per year based on a 60,000 acre-foot per year delivery – a loss of at least 40 percent.

[15]Agreement for Purchase of Water from the Woodbridge Irrigation District by the City of Lodi, April 2003, p.1
[16] J.M. Lord, Incorporated, July 1991, The Lower Mokelumne River Area Crop, Soil, and Water Use Assessment for a Ground Water Storage/Conjunctive Use Study, Final Draft

J.M. Lord reports that at least 90 percent of the soils in the Lodi-Woodbridge area have moderate (1.25-2.5 in/hr) to high (>2.5 in/hr) soil infiltration rates. The report concludes that area soils should not be a constraining factor in a conjunctive use program.

The generally accepted capacity of the WID canal system is about 400 cubic feet per second (cfs). Of this amount, about half can be conveyed through the South Main Canal traversing Lodi, with the Northwest and West Mains splitting the other half in roughly equal portions. The Northwest Main may also receive water pumped into the system from Beaver Slough to a maximum of about 18,000 acre-feet per year.[17]

WID holds two major water rights on the Mokelumne River. The first water right is a pre-1914 water right for 300 cfs of diversion from the Mokelumne River from February 1 to October 31 each year. This water right is overlapped – i.e. claims the same water – by License 5945 obtained from the State Water Resources Control Board (SWRCB). The District's second Mokelumne River water right is a post-1914 water right License 8214 with a diversion rate of 114.4 cfs from May 1 to August 31 of each year. The combined rights under the two licenses together with the District's-1914 rights are limited to a maximum diversion of 414.4 cfs as shown in Table 5.

Table 5: Woodbridge Irrigation District Diversion Rights

Water Rights License	Priority	Source	Rate	Period of Diversion
License 5945	Pre-1914	Mokelumne River	300 cfs	Feb 1 - Oct 31
License 8215	Appropriative	Mokelumne River	114.4 cfs	May 1 - Aug 31
--	Pre-1914	Beaver Slough	--	--

By agreement with EBMUD, a part of the WID right is regulated by EBMUD's Pardee and Camanche reservoirs to provide a Regulated Base Supply during the irrigation season. This regulated supply provides 60,000 acre-feet per year, with a 35 percent reduction to 39,000 acre-feet per year in dry years. At an average consumptive use of 3 acre-feet per acre, this regulated supply is adequate for about 20,000 acres (13,000 acres in dry years). By agreement with EBMUD, WID must take half its regulated supply before July 1. Since approximately 24 percent of demand occurs in July, sustained diversions of about 234 cfs would be required in that month assuming a 60,000 AF supply.

[17] J.M. Lord, Incorporated, July 1991, The Lower Mokelumne River Area Crop, Soil, and Water Use Assessment for a Ground Water Storage/Conjunctive Use Study, Final Draft

Information on WID diversions under its Mokelumne water rights was obtained from the files of the SWRCB, and is presented in Table 6. Over the 23-year period from 1978 through 2000, WID diverted an average of 64,563 AF/yr to irrigate an average 12,545 acres. Average unit water use over this period was 5.15 AF/ac, but this varied widely from 3.22 to 6.91 AF/ac.

WID Purchase Agreement

Water provided to the City will be 6,000 acre-feet per year of the Regulated Base Supply that is surplus to WID's needs due to irrigation efficiency improvements. Supply to the City will be reduced by 50 percent in years when WID's Regulated Base Supply is reduced. Water will be delivered during the period from March 1st through October 15th.[18] At least 3,000 acre-feet must be taken before July 1.

If taken uniformly over the seven-and-one-half-month period, a minimum City diversion capacity of 13.2 cfs (5930 gpm) would be required. Water not taken in the first three years of the agreement can be taken later in the 40 year term of the agreement. Water not taken due to Regulated Base Supply reductions may be diverted within an eight-year period following the reduction. Such reductions happened three times in the four-year period from 1991 through 1994. To allow full utilization of the City contract, a minimum capacity of about 15.4 cfs (6920 gpm, 7000 AF/yr) is required.

Table 6: Historical WID Mokelumne River Diversions 1978 - 2000

Year	Acres Irrigated	Diversion (AF)	Unit Use (AF/ac)
1978	10,084	65,738	6.52
1979	12,557	75,830	6.04
1980	13,052	75,080	5.75
1981	15,550	79,434	5.11
1982	14,730	70,456	4.78
1983	11,698	58,460	5.00
1984	15,083	88,680	5.88
1985	14,790	76,021	5.14
1986	11,584	60,238	5.20
1987	13,802	74,630	5.41
1988	12,134	54,831	4.52
1989	13,801	56,524	4.10
1990	12,907	53,420	4.14
1991	10,293	38,344	3.73
1992	10,852	39,010	3.59
1993	12,317	85,080	6.91
1994	12,223	39,353	3.22
1995	11,492	72,051	6.27
1996	12,770	71,666	5.61
1997	12,726	58,484	4.60
1998	10,213	57,427	5.62
1999	12,135	66,436	5.47
2000	11,744	67,750	5.77
Minimum	10,084	38,344	3.22
Maximum	15,550	88,680	6.91
Average	12,545	64,563	5.15

Source: Annual SWRCB Report of Licensee

[18] Agreement for Purchase of Water from the Woodbridge Irrigation District by the City of Lodi, May 13, 2003.

If additional water is available outside the March – October diversion period, or if additional water above 6,000 acre-feet is available during this period, additional deliveries can be made at $100 per acre-foot upon mutual agreement of the parties. The City has first right of refusal for such water. Non-WID water can be wheeled through WID facilities at a cost of $20 per acre-foot. Beginning in the seventh year of the agreement, all water sales costs will increase in proportion to the Consumer Price Index, or at a minimum two percent per year and a maximum of five percent per year. Table 7 displays the minimum and maximum prices expected for base supply, extra supply, and wheeling over the life of the contract.

Table 7: Current and Projected Unit Cost of WID Water ($/acre-foot)

	Base Supply		Extra WID Supply		Wheeling	
Year	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
2003	$200	$200	$100	$100	$20	$20
2009	$200	$200	$100	$100	$20	$20
2010	$204	$210	$102	$105	$20	$21
2020	$249	$342	$124	$171	$25	$34
2030	$303	$557	$152	$279	$30	$56
2040	$370	$908	$185	$454	$37	$91
2043	$392	$1,051	$196	$525	$39	$105

The City will pay WID $1.2 million, in quarterly installments for the life of the contract, whether or not the City takes delivery of the contracted supply. The contract underwent a validation process[19] to confirm the validity of the contract and provide security for the bonding of dam replacement costs.

North San Joaquin Water Conservation District

The North San Joaquin Water Conservation District (NSJWCD) encompasses approximately 47,000 acres both north and south of the Mokelumne River including portions of eastern Lodi. Two diversion works were installed and a pipeline delivery system partially constructed for NSJWCD to obtain water from the planned extension of the Folsom South Canal into San Joaquin County. The Folsom South Canal was not completed, leaving NSJWCD without a long-term reliable supply of surface water.

The NSJWCD system is a combination of buried pipelines, open canal, and natural waterways (creeks and sloughs). The system has two main pipelines, one north of the Mokelumne River that is almost seven miles long, and one south of the river that is over eight miles long. The south pumping plant has five pumps with a combined 315 horsepower,

[19] Chapter 9 (commencing with Section 860) of Title 10 of Part 2 of the Code of Civil Procedure

which could provide over 50 cfs if not constrained by other elements of the distribution system. Of the 47,000 acres of farmland within NSJWCD boundaries, fewer than 5,500 are currently connected to the distribution system.[20]

NSJWCD has a temporary water right for Mokelumne River water. This right expired in 2002 and the District is in the process of renewing it. The District has an agreement with EBMUD to regulate up to 20,000 acre-feet per year upstream in Camanche Reservoir. Direct diversions of up to 80 cfs are permitted from December 1 through July 1.[21] During drought periods no regulated surface supply is available and growers rely on groundwater. Multi-year electrical power contracts have reduced growers' pumping costs increasing their reliance on groundwater to the detriment of using surface water supplies. NSJWCD has never used more than 9,500 acre-feet in any year, and recent years have averaged about 3,000 acre-feet per year. Water users are currently charged a flat rate of $50 per acre.[22]

In an effort to increase conjunctive use opportunities NSJWCD recently passed a land use assessment of $1 per acre to pay for a pilot groundwater recharge project. Using these initial funds NSJWCD has begun percolation of Mokelumne River water on 25 acres of vacant farmland near Highway 12 and Locust Tree Road. The project uses one of the district's water pumps to divert river water to demonstrate the benefits of groundwater recharge.

If the initial recharge projects are deemed successful the annual land use assessment fee could increase to a maximum of $5 per acre to percolate a minimum of 12,000 acre-feet of Mokelumne River water into the NSJWCD service area[23]

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[20] J.M. Lord, Incorporated, July 1991, The Lower Mokelumne River Area Crop, Soil, and Water Use Assessment for a Ground Water Storage/Conjunctive Use Study, Final Draft
[21] Water Right Application A12842, Permit 10477
[22] Personal communication, E. Steffani, May 28, 2003. Rate was reported as $35/acre in J.M. Lord, 1991
[23] California Water Code, Section 75480 et seq.

Section 4. Feasibility of New Appropriations

A number of water right applications are currently filed on water bodies near the City. They include San Joaquin County conjunctive use projects from the Mokelumne and American Rivers, EBMUD diversion to the Mokelumne Aqueduct via the Sacramento River near Freeport, and diversions from the Delta for the City of Stockton. The city could potentially partner with any of these interests to increase surface water supply.

Mokelumne River Water and Power Authority (Middle Bar/Duck Creek)

The Mokelumne River Water and Power Authority (an entity administered entirely by San Joaquin County with support from the cities of Lodi and Stockton) filed Application 29835 to appropriate from the Mokelumne River up to 620 cfs by direct diversion and 434,000 AF to storage with the total not to exceed 544,000 AF/yr.

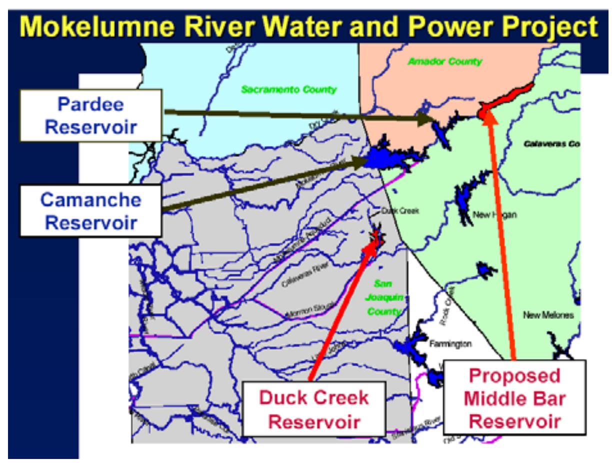

Figure 9: Mokelumne River Water and Power Project

Two alternative points of diversion are proposed in Application 29835:[24]

> Alternative A: Construction of Middle Bar Reservoir on the Mokelumne River upstream of Pardee Dam, a diversion works and tunnel from Pardee Reservoir and conveyance to a new 150,000 AF reservoir at the Duck Creek site for release to the Calaveras River. A second water right application (29855) would divert up to 3000 cfs for power generation purposes at the

[24] Figure adapted from http://www.co.san-joaquin.ca.us/TopLevelDocs/BOS_WMP_Adoption_051302.pdf

Middle Bar Dam site.[25] The Middle Bar option has been dropped from further consideration.[26]

Alternative B: Same as Alternative A, but without Middle Bar Reservoir.

The Authority is in the process of developing this water right. The SWRCB is authorized to declare a stream fully appropriated. If a stream is declared fully appropriated, SWRCB may reject any water right application filed on that stream. If a stream has been declared fully appropriated for part of a year, the Board may modify the application. The SWRCB has declared the Mokelumne River system fully appropriated for the period from March through November. The Board modified this in November 1998[27] to allow applications for conjunctive use projects on the Mokelumne River from March through June. Evidence of water availability for conjunctive use projects will be evaluated in the course of processing the applications.

The County retained engineering consultant HDR for the first phase of work, which was initiated in April 2003. A draft Reconnaissance Study report was completed in January 2004. Of the 21 alternatives considered in this study, five are recommended for further study:

- On-stream alternatives
    - Mokelumne River storage system reoperation
- Off-Stream storage alternatives
    - Duck Creek Reservoir with diversion from Pardee Reservoir
    - Duck Creek Reservoir with diversion from Camanche Reservoir, and
- Direct diversion alternatives
    - new Lower Mokelumne diversions
    - Lower Mokelumne River diversions using existing facilities

Of these alternatives, Mokelumne River reoperation and Lower Mokelumne River diversions using existing facilities direct diversion were ranked "low" for benefits that would be achieved. New Lower American River were estimated to yield an average of 49,000 acre-feet per year at a cost of $150 per acre foot. The Duck Creek alternatives were estimated to

[25] The proposed project would consist of: (1) a proposed 190-foot-high, 800-foot-long Concrete Arch dam; (2) a proposed reservoir having a storage capacity of 40,000 acre-feet with normal water surface elevation of 684 feet msl; (3) a proposed intake structure; (4) a proposed 200-foot-long 15-foot-diameter steel penstock; (5) a proposed powerhouse containing one generating unit with an installed capacity of 31-MW; (6) a proposed outlet works; (7) a proposed 3-mile-long, 230-kV transmission line; and (8) appurtenant facilities. The project would have an annual generation of 80 GWH and would be sold to a local utility. http://www.epa.gov/fedrgstr/EPA-IMPACT/1998/October/Day-08/i26959.htm

[26] Mokelumne River Water & Power Authority, June 2004, MORE WATER Project Phase I Report, Mokelumne River Water Storage and Conjunctive Use Project

[27] Water Rights Order 98-08, November 19, 1998

yield between 82,000 to 90,000 acre-feet per year (depending on hydropower impacts) at a cost of between $150 and $210 per acre-foot. It should be noted that these costs are for development only of the water supply – additional facilities would be required to convey, treat, or recharge this water at additional cost.

The workplan calls for environmental documentation to be completed in 2005, and water rights and power generation permits issued by June 2006. Construction would start in 2009 and the project would be on line in 2012.

American/Sacramento Rivers

San Joaquin County has a pending application to appropriate water from the South Fork American River. The State Water Resources Control Board designated this Application 29657 and assigned it a priority date of February 9, 1990.

Application 29657 seeks the right to divert for direct use up to 620 cubic feet per second (cfs) from December 1 through June 30 each year, up to 105,000 acre-feet per year (AF/yr). Diversion to storage of up to 190,000 AF/yr is also proposed. Including losses of 27,000 AF/yr, up to 322,000 would be taken by direct diversion and diversion to storage during any one year.

Two alternative points of diversion are proposed in Application 29657:

> Alternative A: Diversion from Nimbus Dam to the Folsom South Canal to storage in a new reservoir at the Clay Station site. This alternative would require extension of the Folsom South Canal into San Joaquin County and construction of Clay Station Reservoir.
> Alternative B: Diversion from the South Fork American River upstream of Folsom Reservoir[29] to new reservoirs at the County Line and Clay Station sites. This alternative would require construction of a South Fork diversion structure and tunnel, County Line and Clay Station reservoirs, and conveyance between the reservoirs and into San Joaquin County.

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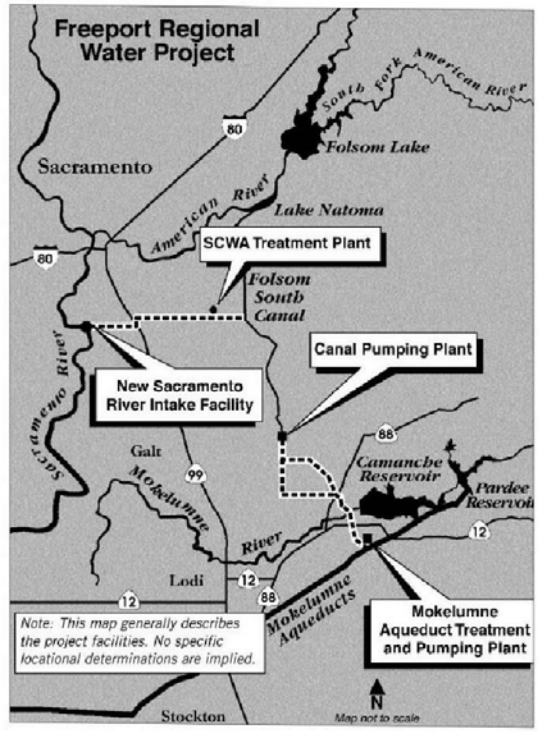
[28] Water Rights Order 98-08, November 19, 1998
[29] Diversion would be from the South Fork in the SE corner of the NE quadrant of Section 31, Township 11N, Range 9E, Mt. Diablo BM in El Dorado County.

The SWRCB has declared the American River system fully appropriated for the period from July 1 through October 31. If diverted continuously at the diversion rate of 620 cubic feet per second over the December 1 through June 30 period of diversion, there is capacity to divert up to 260,700 acre-feet, though the application limits direct diversions to 190,000 acre-feet per year.



Source: http://www.freeportproject.org

Figure 10: Freeport Project

The County is in the process of revising Application 29657 to move the point of diversion to the Freeport diversion site on the Sacramento River.[30] The Sacramento County Water Agency and East Bay Municipal Utility District are in the process of developing a 286 cfs diversion at the Freeport site. Of this capacity, 131 cfs would be used in most years to meet needs within Sacramento County. The other 155 cfs would be conveyed to a connection point with EBMUD's Mokelumne Aqueduct in San Joaquin County. EBMUD only needs this capacity in approximately one-third of the driest years. The capacity could be made available to San Joaquin County or other users about two-thirds of the time in average and wetter years.

If diverted at a maximum rate of 155 cfs, the average annual diversion to San Joaquin County under the revised application would be about 44,000 AF/yr.[31] Operations costs to pump water from Freeport to a connection point on the Mokelumne Aqueduct is estimated by EBMUD as about $106/AF.[32] Capital repayment, based on potential San Joaquin County use of the Freeport facilities, could be as high as $180/AF.[33]

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[30] Maximum diversion of 350 cfs, 147 KAF/yr specified in amendment filed August 12, 2003.
[31] Saracino-Kirby-Snow, May 2003, South Fork American River Water Availability Study San Joaquin County Water Right Application 29657 Progress Report
[32] Without treatment or pumping into the Mokelumne Aqueduct. Excludes possible capital repayment costs that might be negotiated with EBMUD.
[33] Facilities necessary for San Joaquin County delivery (e.g. without treatment) total about $280M of $627M total. Capital recovery at 6% and 25 years.

Participation in Stockton Delta Diversion Project

The City of Stockton is pursuing development of a new surface water supply from the Delta, together with associated treatment and distribution works. A new surface water supply will assist the City of Stockton in mitigating the problems of overdraft, saline migration, declining surface water supply, and future water supply needs.

The City of Stockton Delta Water Supply Project would divert up to 125,900 AF/yr from the San Joaquin River in the Delta by 2050. Water would come from the City's rights under SWRCB Decision 1485 which is tied to its wastewater discharges, area of origin filings, and new appropriations or transfers. A water rights application was submitted to the SWRCB on January 6, 1996, which was publicly noticed December 1997. The application requests an increasing amount of surface water starting from 20,000 AF/yr in 2002 to 125,900 AF/yr in 2050. The application specifies a place of use coincident with Stockton's General Plan Boundary. The application includes up to four possible points of diversion from the Delta. The preferred site is on the San Joaquin River at the southwestern end of Empire Tract. Water would be conveyed along Eight Mile Road to a new water treatment plant in the vicinity of Eight Mile Road and Interstate 5, approximately 5 miles from Lodi.[34] As of May 2003, neither detailed design nor environmental documentation had been initiated.

It is anticipated that full diversion amounts will not be available from the Delta year-round. Stockton plans to treat surface water in times of surplus for injection into the groundwater basin. This water could be withdrawn during times of shortage within the Delta. Injection in Stockton would help retard salinity intrusion, meet City obligation for groundwater recharge, and provide operational storage and drought supply.
The first 30 MGD phase of Stockton's Delta Water Supply Project has an estimated capital cost of $121 million. Capital repayment plus operating costs are estimated to translate into a treated water cost of approximately $350 per acre-foot.[35]

Three factors that must be considered in any Delta Diversion project are the CalFed Bay-Delta process, Area of Origin water rights, and State Water Resources Control Board Term 91. Each of these is discussed briefly below.

Bay-Delta Process

In 1994, state and federal water agencies developed a collaborative management structure to provide the regulators and the public a forum to develop a comprehensive Bay-Delta plan.

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[34] Environmental Sciences Associates, January 2003, Feasibility Report City of Stockton Delta Water Supply Project
[35] Earth Sciences Associates, 2003, Feasibility Report City of Stockton Delta Water Supply Project, p.25

The 1992 Governor's Water Policy, the 1993 Federal Ecosystem Directorate, the June 1994 Framework Agreement, and the December 1994 Bay-Delta Accord grounded the new approach to California water planning and management that evolved into the collaborative called CALFED, now called the California Bay-Delta Authority.

The signatories to the agreements became responsible for managing and overseeing various activities to implement the agreements. They agreed to work together to set water quality standards, coordinate State Water Project and Central Valley Project operations, and develop long-term solutions to problems in the Bay-Delta Estuary.

CALFED has brought divided interests together to discuss their differences and it seeks to move projects and programs forward despite legal, institutional, and financial challenges. CALFED's mission is "to develop and implement a long-term, comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system."

Area of Origin

The area of origin statutes in California water law apply to the appropriation of water and address the relative priority of water rights held for uses within the area of origin to the water rights held for uses outside an area of origin.

There are three statutes that cover what are referred to as area of origin water rights. Under these statutes, water right applicants within the area of origin are assured that new water right applications filed for the development of water within the area of origin will not be rejected by the State Water Resources Control Board on the basis that no water is available for appropriation by virtue of a senior water right to export the water from the watershed. The three statutes are as follows:

- Watershed Protection Act WC11460 (State and Federal projects)
- County of Origin WC10505 (1927 State filings include 180 KAF on the Mokelumne River)
- Delta Protection Act WC12204

The Watershed Protection Act contained in California Water Code § 11460 states that "in the construction and operation by the department of any project under the provisions of this part a watershed or area wherein water originates, or an area immediately adjacent thereto which can conveniently be supplied with water there from, shall not be deprived by the department directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein."

The County of Origin Statutes, at Water Code § 10505 and 10505.5, state "no priority under this part shall be released nor assignment made of any application that will, in the judgment of the board, deprive the county in which the water covered by the application originates of any such water necessary for the development of the county."

The Delta Protection Act incorporates by reference the county of origin and watershed protection statutes, and declares the policy of the state "that no person, corporation or public or private agency or the state or the United States should divert water from the channels of the Sacramento-San Joaquin Delta to which the users within said Delta are entitled." Id. § 12203. See id. § 12220

Term 91

Term 91 is a condition that the State Water Control Board (SWRCB) can attach when issuing water rights. Term 91 prohibits diversion of water when flows into the Sacramento-San Joaquin Delta and its tributaries are insufficient to meet water quality objectives in the Delta. The specific regulations of Term 91 are the following:

> No diversion is authorized by this license when satisfaction of inbasin entitlements requires release of supplemental Project water by the Central Valley Project or the State Water Project.
>
> A. Inbasin entitlements are defined as all rights to divert water from streams tributary to the Sacramento-San Joaquin Delta or the Delta for use within the respective basins of origin or the Legal Delta, unavoidable natural requirements for riparian habitat and conveyance losses, and flows required by the State Water Resources Control Board (SWRCB) for maintenance of water quality and fish and wildlife.
>
> B. Supplemental Project water is defined as water imported to the basin by the projects, and water released from Project storage, which is in excess of export diversions, Project carriage water, and Project inbasin deliveries.
>
> The SWRCB shall notify the licensee of curtailment of diversion under this term after it finds that supplemental Project water has been released or will be released. The SWRCB will advise the licensee of the probability of imminent curtailment of diversion as far in

advance as practicable based on anticipated requirements for supplemental Project water provided by the Project operators."

Water Appropriations Summary

There are several ongoing efforts in the region to obtain new surface water appropriations. The City of Lodi has varying degrees of involvement in each of these efforts, which include:

- the Mokelumne River Water and Power ("More Water") Project
- San Joaquin County/GBA diversion from the American/Sacramento rivers
- the City of Stockton Delta Supply Project

The Mokelumne River Water and Power ("More Water") Project being developed by a consortium of San Joaquin County agencies including Lodi. The project would involve a new diversion from the Mokelumne River and off-stream storage at the Duck Creek site, and potentially a new reservoir on the Mokelumne River at the Middle Bar site. A water right application has been submitted. A draft reconnaissance study was completed in January 2004. Environmental documentation is scheduled to be completed in 2005. Cost of this water supply is estimated at between $150 to $210 per acre-foot, plus the cost to convey, treat, and recharge this water.

San Joaquin County has applied for a water right from the South Fork American River and has recently amended the application to allow diversion from the Sacramento River at the Freeport site. The County is working with San Joaquin County Groundwater Banking Authority, of which Lodi is a member, to develop this concept into a groundwater banking project. Cost to deliver this water to San Joaquin County would be about $290 per acre-foot, plus the cost of groundwater recharge facilities.

The City of Stockton Delta Supply Project would divert up to 125,900 acre-feet per year from the San Joaquin River in the Delta by 2050. A water right application was submitted in 1996 and environmental documentation is underway. The preferred option would convey water along Eight Mile Road to east of Interstate 5, approximately five miles from Lodi. Full diversion amounts are not expected to be available year-round, and groundwater banking in north Stockton is planned to bridge this shortfall. Lodi might participate in development of regional groundwater recharge facilities. A preliminary estimate projects a unit cost of $350 per acre-foot of treated potable supply. The City of Stockton has informally expressed interest in purchasing of a portion of the Lodi WID water as an interim supply until the project is permitted and constructed.

Section 5. Options for Use of Surface Water Supply

The following section evaluates various surface water supply options available to the City. In light of the recent contract for 6,000 acre-feet on annual supply from WID, the majority of alternatives in the above list are proposed to utilize water supply from the WID South Main Canal. Regional alternatives with water sources other than WID include the NSJWCD and EBMUD alternatives. The alternatives evaluated include surface water irrigation of parks and schools using a portion of the WID supply, injection of surface water, percolation of surface water, and direct surface water treatment and supply. The following are alternatives reviewed for this study:

- Surface Water Irrigation to Parks and Schools Using WID South Main Canal
- Injection Well Recharge Alternative
- Recharge Ponds Utilizing WID South Main Canal
    - Westside Recharge Pond
    - Eastside Recharge Pond
- Surface Water Treatment Plant and Distribution
- Southeast Recharge Utilizing NSJWCD Facilities
- EBMUD Banking and Large Scale Pump Back
- Interim Supply to Stockton Recharge Ponds

Design Assumptions Common to All Alternatives

Certain common design assumptions were used in the majority of alternatives. If a common design assumption mentioned in this section is modified based upon an alternative it is explicitly stated in the section describing that particular alternative.

Alternatives in this assessment have the following common design assumptions:

- Surface water supply is available for eight months of every year.
- 7,000 acre-feet of water is the design capacity.
- Pipelines have a design velocity of five feet/second.
- Land cost $30,000/acre outside Lodi's "General Plan boundary with Reserve" and $100,000/acre inside this boundary.

- Average power cost is $0.15 per kWh
- Recharge basin alternatives assume a percolation rate of 1.0 foot/day
- Recharge basin alternatives assume a peaking factor of 2.0[36]

Cost Assumptions Common to All Alternatives Evaluated

To compare the relative cost of each alternative for utilizing the surface water supply a unit cost methodology was developed to estimate capital, operating and maintenance costs. Unit cost for the majority of components evaluated including pipelines, pumping stations, injection facilities, and recharge basins were adapted from the *Mokelumne Aquifer Recharge and Storage Project, March 1996* (MARS).[37] To update the 1996 unit cost in the MARS study the Engineering News-Record Construction Cost Index was referenced. The evaluation of the index found that construction costs have increased approximately 22% from January 1996 to June 2000. This factor was used to adjust 1996 unit cost to the 2003 unit cost numbers presented in Table 8.

Table 8: 2003 Unit Construction Cost (Capital)

Type of Facility	Unit	Unit Cost
Pump Stations < 2000 HP	HP	$1,710.00
Pipelines < 90" diameter[1]	dia-in-ft	$6.10
Bore and Jack Crossings, Tunneling	dia-in-ft	$24.50
Recharge Basin Construction	acre	$42,820.00
Fish Screen	cfs	$6,120.00
Injection Wells[2]	each	$305,890.00
Extraction Wells	each	$208,000.00
Surface Water Treatment Plant[3]	gpd	$1.00

[1] Assume pipelines in Lodi will not need shoring
[2] Assumes dedicated well pump for backflushing and development
[3] Reference: Alternatives for Water Supply from the California Aqueduct (Parsons - February, 2001)

Annual operating and maintenance costs were also taken from the MARS study. The costs are based on a project life of 50 years with replacement of electrical/mechanical equipment after 25 years. Table 9 presents the values used to calculate annual O&M costs. Where applicable, power costs were added to annual O&M assuming an average rate of $0.15 per kWh.[38]

[36] A "peaking factor of 2.0" means that twice as much capacity is provided than would be necessary if the facilities were operated continuously at a constant rate. This conservative factor provides an allowance for taking facilities off-line for maintenance, to account for variance in water availability and canal flow (e.g. during irrigation season), and to offset uncertainties in estimated design parameters (e.g. sustainable percolation rate). The annual period when water is not available may be adequate for pond maintenance.
[37] Montgomery Watson Americas, 1996
[38] High-end 2001 California Energy Commission numbers from http://www.energy.ca.gov/electricity/current_electricity_rates.html

Table 9: Annual Operation and Maintenance Costs		
Type of Facility	**Unit**	**Unit Cost**
Pump Station	capital cost	4.0%
Pipelines	capital cost	0.5%
Injection Wells	capital cost	5.0%
Extraction Wells	capital cost	4.0%
Recharge Basins	capital cost	4.0%
Water Treatment Plant	capital cost	6.0%
Tertiary Treatment Plant	capital cost	6.0%
Miscellaneous Concrete Structures, i.e. canal turnouts	capital cost	2.0%
Filter Plant	capital cost	1.0%

Surface Water Irrigation to Parks and Schools Using WID South Main Canal

All parks and schools within one mile of the WID South Main Canal with an area greater than five acres were included in this analysis to estimate the cost of delivering surface water via the WID South Main Canal in-lieu of utilizing groundwater for irrigation. Metered data for parks in Lodi was available for the years 2000-2002. Table 10 displays the average use for each of these years. The average use of water at Lodi parks during 2002 was three acre-feet per acre. The average use of water at Lodi schools during 2002 was two acre-feet per acre. These values were used to size the necessary distribution facilities from the WID South Main Canal.

Table 10: Lodi Irrigation Water Demand (acre-ft/acre)

	2000	2001	2002
Schools	1.93	2.08	2.08
Parks	2.22	2.61	3.03
Average use	2.07	2.33	2.56

Source: Lodi Metered Water Data

Facility sizes were estimated based on a 36-week irrigation season per year. Assuming irrigation is evenly spaced during the 36 weeks, every park and school would receive 1/36 of the total irrigation demand each week during the irrigation period. It is assumed that each park and school would be irrigated in six 8-hour time periods each week. Therefore, each park is assumed to receive one inch of water each week from 6 separate 8-hour irrigation periods. While each school is assumed to receive 0.67 inches of water each week from 6 separate 8-hour irrigation periods.

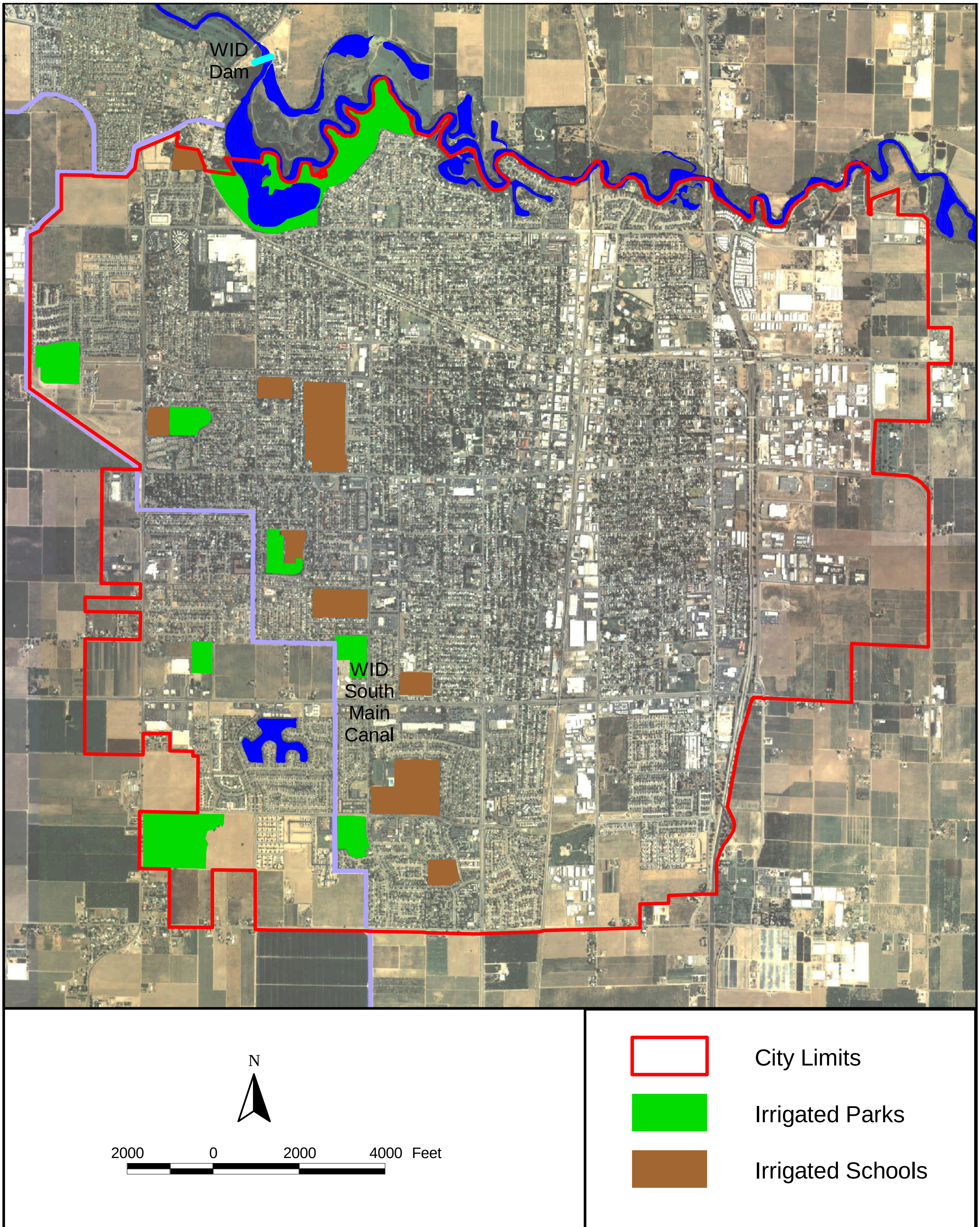
Cost estimates are based on this demand analysis for pipeline diameters, pipeline lengths, and pumping station capacities required to deliver surface water to the existing distribution systems for parks and schools. The analysis found that parks and schools within one mile[39] of WID South Main Canal could utilize approximately 1,030 acre-feet of water each year. The total cost of distributing water to parks and schools is estimated to be approximately $1.8 million.

The least economical facilities are small parks and schools served by a long pipeline from the canal. Excluding these facilities yielded a utilization of 1,000 acre-feet of water each year with a capital cost of approximately $1.4 million. Table 11 shows the project level cost estimate with the least economical facilities removed. Costs to pump this water may be offset by savings from curtailing current well pumping, though this has not been explicitly evaluated. Figure 11 shows the location of parks and schools included in the $1.4 million dollar estimate.

Table 11: Surface Water Irrigation (Non-Potable) to Parks and Schools

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
3" Pipeline	8,000	feet	$18	$146,000	0.5% of capital	$700
6" Pipeline	8,500	feet	$37	$311,000	0.5% of capital	$1,600
10" Pipeline	4,000	feet	$55	$220,000	0.5% of capital	$1,000
Pump 10 HP	8	each	$17,100	$137,000	4% of capital + power	$25,000
Pump 20 HP	3	each	$34,200	$103,000	4% of capital + power	$19,000
Pump 30 HP	1	each	$51,300	$51,000	4% of capital + power	$8,000
Pump 50 HP	1	each	$85,500	$86,000	4% of capital + power	$13,000
30% Contingency				$316,000	n/a	
			Total:	$1,400,000		$68,000

[39] One mile distance to capture the band of irrigated areas roughly following the South Main Canal on Lodi's west side. An additional 120 acres of future parks might also be served.



Saracino·Kirby·Snow
A Schlumberger Company

Irrigation of Parks and Schools
Within 1-Mile of WID South Canal

City of Lodi
Surface Water Supply Options

Figure 11

Date: October 2003

Prepared By: BCW

Injection Well Recharge Alternative

Injection wells are a logical alternative for recharging groundwater where available land is limited or costly, or where near-surface soils restrict conductance to deeper aquifers. The alternative evaluated assumes that surface water supplied from the WID South Main Canal would be pretreated and injected into the aquifer underlying Lodi for storage and subsequent removal using the City's water supply wells.

As a rule of thumb, water can generally be injected at about half the rate of extraction. City wells range in production from 700 to 2,000 gpm, and average 1,350 gpm. New production wells average about 1,600 gpm. Assuming an average injection rate of 800 gpm, and a peaking factor of 2.0[40], Lodi would need 16 injection wells to recharge 7,000 acre-feet/year over an eight month time period. The Beckman test injection/extraction pilot project[41] demonstrated that injection of Mokelumne Aqueduct water was feasible in the San Joaquin County aquifer system. The test report concluded that capacities of 500 to 1000 gpm were feasible.

Feasibility

A notable concern with injection wells is the amount of draw-up during injection operation. Injection draw-up in an aquifer system is analogous to the inverse of pumping draw-down and is typically modeled in the same fashion. Water levels underlying the City are typically between 30 and 75 feet below the ground surface. Injection draw-up greater than this range could limit injection feasibility. The aquifer underlying the City is assumed to be unconfined.

To predict the change in the water table from injection well operation a FORTRAN computer program was used to simulate groundwater flow in a 2-D unconfined, heterogeneous, isotropic aquifer. The aquifer properties are based on the Beckman Test[42] and a review of previous groundwater studies[43] and are considered reasonable for the aquifer underlying Lodi. The model used is based on the Boussinesq equation, which has the assumption of no

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[40] A "peaking factor of 2.0" means that twice as much capacity is provided than would be necessary if the facilities were operated continuously at a constant rate. This conservative factor provides an allowance for taking facilities off-line for maintenance, to account for variance in water availability and canal flow (e.g. during irrigation season), and to offset uncertainties in estimated design parameters such as aquifer transmissivity. Pumping tests might be conducted to refine the estimate of aquifer transmissivity and storativity. Well recovery tests on City wells analyzed for this analysis show transmissivity in the range of 74,000-89,000 gpd/ft, about 6-20 percent greater than those found in the Boyle tests.
[41] Boyle, 1999
[42] Boyle, 1999
[43] Eastern San Joaquin County Groundwater Study (1985); J.M. Lord, Incorporated, July 1991

vertical flow, and is approximated using a finite difference discretization. The model generates output containing the hydraulic head (water table) at each grid node of the defined model for each time step. For conservative analysis, the model was run to steady state to predict the maximum rise in groundwater elevation from injection operations.

Table 12 was used to calibrate aquifer parameters for model input based on the average drawdown from current Lodi production wells. Only wells with average production rates greater than 1,000 gpm were used for calibration. The model was then validated using pump test data from Well 24.

Table 12: Average Drawdown of Production Wells, 2002

Well Number	Static Water Level	Average Production	Pumping Water Level	Drawdown
1R	66.5	1,151	95.9	29.5
4R	70.0	2,044	110.4	40.4
5	45.6	1,230	61.9	16.2
6R	64.6	1,403	89.2	24.6
7	35.6	1,100	85.8	50.3
11R	56.3	1,313	103.7	47.5
14	46.2	1,586	72.2	26.0
15	41.2	1,585	91.6	50.4
16	57.8	1,038	116.8	59.0
17	51.1	1,789	102.4	51.3
18	65.1	1,779	110.0	44.9
19	66.1	1,130	96.0	29.9
22	75.0	1,418	141.3	66.3
23	69.0	1,469	115.0	46.0
24	57.2	1,429	147.6	90.4
25	45.4	1,624	97.2	51.7

Figure 12 shows the modeled groundwater elevation of a single injection well at steady state with an injection rate of 800 gpm. It is important to note that the steady state assumption uses continuous injection at 800 gpm while actual conditions would vary with less than constant injection subject to water supply availability and well maintenance. Thus, this analysis would be considered conservative and represent the upper limit of draw-up at an injection rate of 800 gpm. As shown in Figure 12 the water level near a single injection well reaches a maximum draw-up of 24 feet.

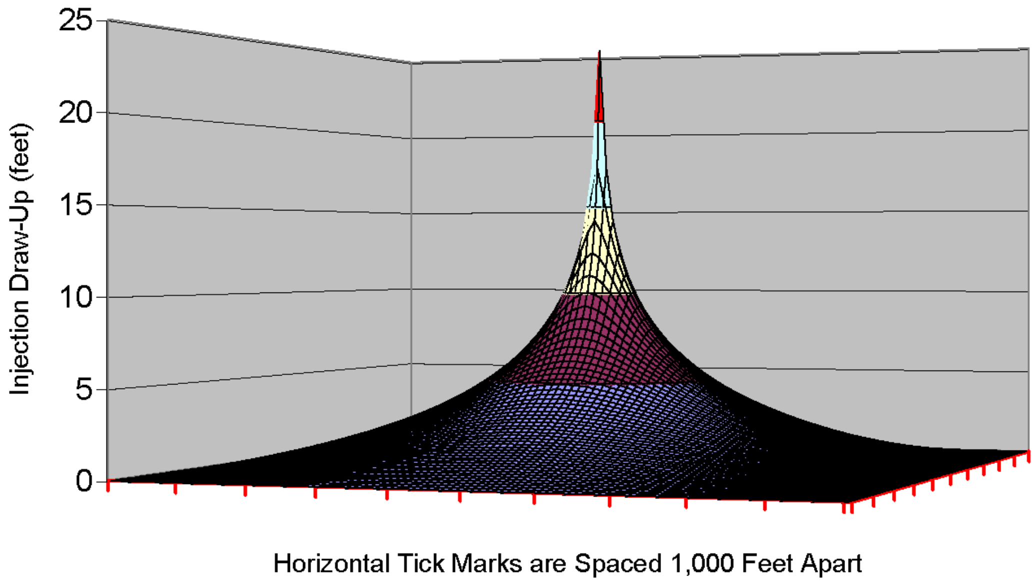

Figure 12: Single Injection Well at 800 gpm Steady State Draw-Up

To achieve 7,000 acre-feet of recharge per year by injection with a peaking factor of 2.0 it is estimated that 16 injection wells are needed. Placing multiple injection wells in close proximity to each other can increase water levels based on the principle of superposition. To predict the change in water levels from multiple injection wells the model was run utilizing five injection wells spaced 2000 feet apart along a line. Figure 13 shows the draw-up for this analysis. As shown on Figure 13, the maximum draw-up at the center injection well is 40 feet during steady state simulation at 800 gpm.

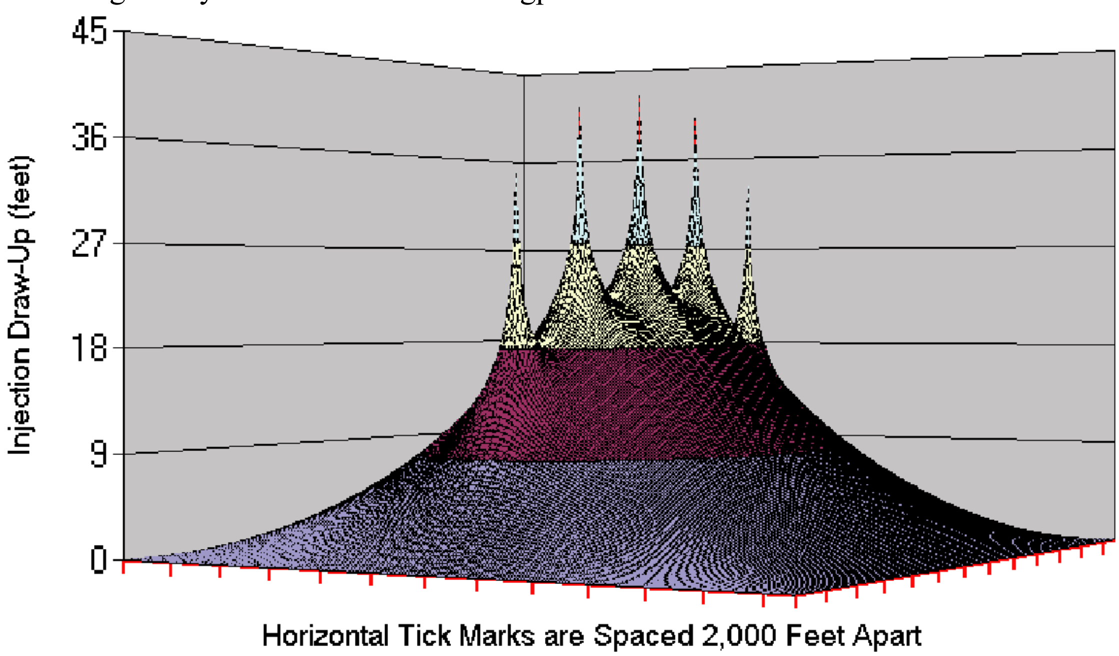

Figure 13: Multiple Injection Wells at 800 gpm Steady State Draw-Up

Given the current depth to groundwater within City limits this analysis leads to a few conclusions. As shown in the groundwater elevation contours, Figure 8, the depth to groundwater increases from 30 to 75 feet within City limits as one moves south from the Mokelumne River. Wells spaced nominally 2,000 feet apart injecting at a rate of 800 gpm are feasible in the southern portions of the City where the depth to groundwater is greatest. Injection near the Mokelumne River may be problematic because of the higher groundwater elevations. Wells injecting at a lower rate spaced further apart than 2,000 feet may be possible for recharge nearer the Mokelumne River.

To determine if injection wells could be spaced closer than 2,000 feet apart within the City service area, the model was re-run using scenarios of 1,000 foot spacing as well as 500 foot spacing. The aquifer parameters, injection rate, and number of injection wells were kept constant as in the 2,000 foot simulation. The model runs simulated maximum injection draw-ups of 53 feet and 65 feet for the 1,000 foot and 500 foot spacing, respectively.

Given the observed standing water elevations of Lodi municipal supply wells[44] the maximum simulated level of draw-up from the 500 and 1,000 foot spacing is too great for current groundwater elevations. An injection well spacing of 1,000 feet or greater might be feasible in the southern portion the City's service area, depth to groundwater of the five southernmost wells (16, 18, 19, 22, and 23) show a range between 57 to 75 feet in 2002, but for a conservative analysis the spacing of the injection wells was kept at a nominal 2,000 feet as shown in Figure 14.

It is recommended that the City conduct additional pumping tests to provide a better estimate of aquifer parameters, and to conduct a full scale injection pilot test to confirm whether well draw-up will be a constraining factor. Isolating coarse, high-permeable soils for receiving injection water might allow recharge goals to be met with fewer wells.[45]

Water Quality Requirements

In general, water to be injected down wells must be free from suspended solids and other matter that could clog aquifer pore spaces. An injection test performed by the East San Joaquin Parties Water Authority[46] in 1998 successfully used Mokelumne River water from Pardee Reservoir by limiting injection to water with less than 2 nephelometric turbidity

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[44] Data from City of Lodi, Public Works Department: Standing Water Level for years 1992-2002
[45] Summer 2004 well recovery tests on City wells analyzed for this analysis show transmissivity in the range of 74,000-89,000 gpd/ft, about 6-20 percent greater than those found in the Boyle analysis.
[46] Boyle, 1999 Beckman Test Injection/Extraction Project

units[47] (NTU). Water diverted from the lower Mokelumne River through the unlined WID canals is expected to be considerably more laden with suspended solids and will require treatment before injection. Typical treatment methods include sand or membrane filtration.

The groundwater underlying the City is primarily seepage from the Mokelumne River, so injection of River water is not expected to have adverse geochemical reactions. Incompatible waters may cause precipitation of various compounds on the well screen, filter pack, or aquifer materials, which can substantially decrease the capacity of the well over time. Incompatible waters may also cause swelling of aquifer clays that may cause clogging of the aquifer pore structure. A water quality compatibility analysis[48] should be performed to determine the potential for such reactions as part of an injection feasibility investigation.

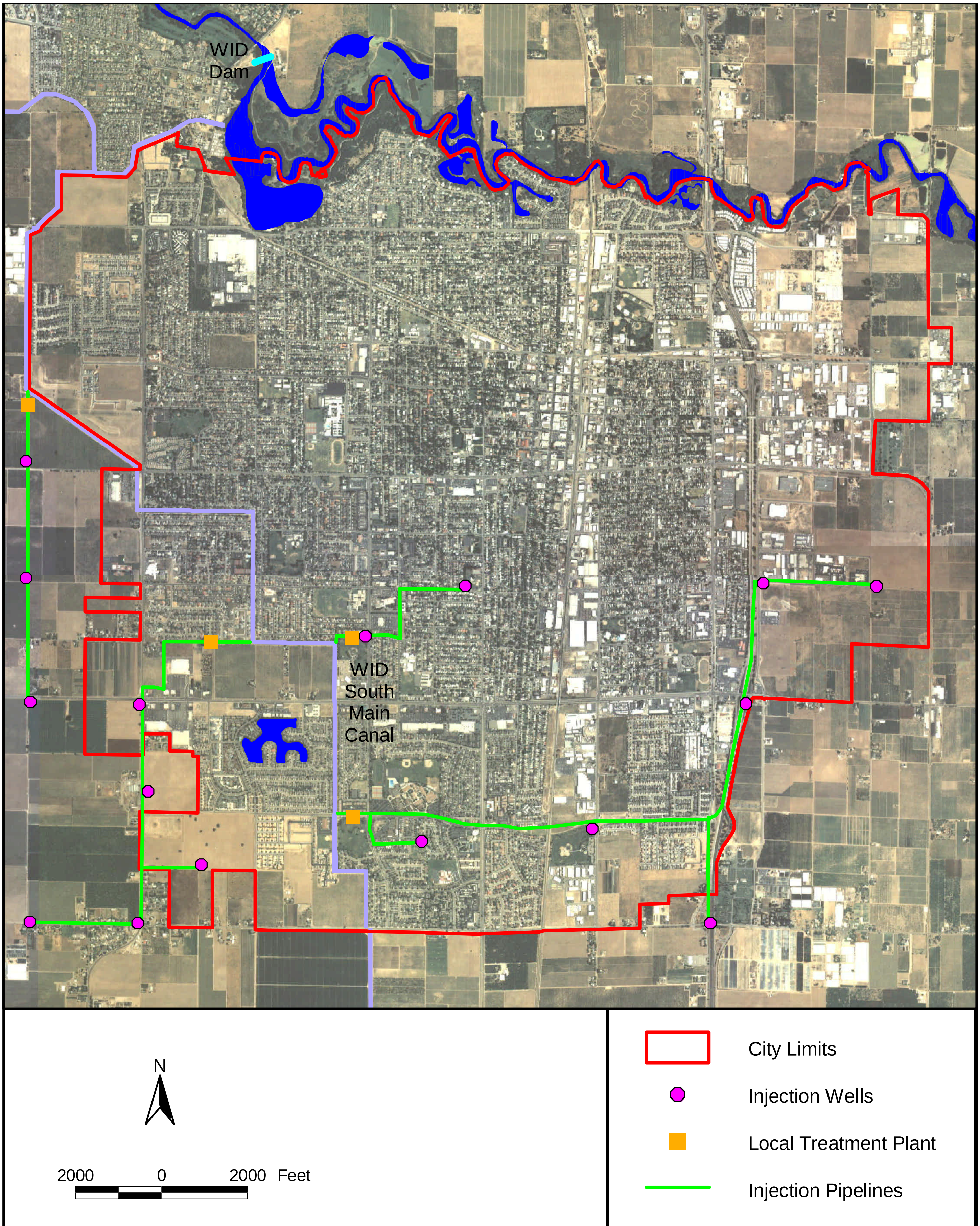
It is desirable to disinfect injected water to ensure a disinfectant residual within the well and gravel pack to control bacterial activity and prevent bacterial plugging. If soil materials or native water would result in formation of disinfection byproducts, dechlorination may be required prior to injection.

Cost Estimate

Cost estimates are based on 16 injection wells equipped with pre-treatment and chlorination facilities. Figure 14 displays a possible layout of the injection wells throughout the City. Injection wells in Figure 14 are spaced nominally 2,000 feet apart and no closer than 2,000 feet from any point of extraction. As shown in Table 13, the estimated capital cost of facilities is $14.6 million with an average O&M of $520,000.

[47] A measure of the light-scattering properties, or 'cloudiness' of turbid water
[48] This is a relatively straightforward assessment of the potential of mixed waters to generate gasses or precipitating minerals that can clog aquifer materials which is performed with conventional hydrogeochemical modeling software with measured water constituents as input

Table 13: Injection Well Alternative						
Facility	**Quantity**	**Units**	**Unit Cost**	**Capital Cost**	**Annual O&M Rate**	**Annual O&M Cost**
12" Pipeline	17,500	feet	$73	$1,281,000	0.5% of capital	$6,000
15" Pipeline	8,100	feet	$92	$741,000	0.5% of capital	$4,000
18" Pipeline	6,400	feet	$110	$703,000	0.5% of capital	$4,000
24" Pipeline	14,000	feet	$146	$2,050,000	0.5% of capital	$10,000
30" Pipeline	1,000	feet	$183	$183,000	0.5% of capital	$1,000
Injection Wells	16	each	$306,000	$4,896,000	5% of capital	$245,000
Pump 50 HP	1	each	$85,500	$86,000	4% of cap + power	$17,000
Pump 80 HP	1	each	$136,800	$137,000	4% of cap + power	$32,000
Pump 110 HP	1	each	$188,100	$188,000	4% of cap + power	$80,000
Pump 200 HP	1	each	$342,000	$342,000	4% of cap + power	$79,000
Filtration Unit (2200 gpm)	6	each	$50,000	$300,000	6% of capital	$18,000
Disinfection Unit (Cl)	16	each	$20,000	$320,000	6% of capital	$19,000
30% Contingency				$3,370,000	n/a	
			Total:	$14,600,000		$520,000



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Injection Well Alternative

City of Lodi
Surface Water Supply Options

Figure 14

Date: October 2003

Prepared By: BCW

Recharge Ponds Utilizing WID South Main Canal Surface Water

Conjunctively using surface water from the WID South Main Canal to recharge the groundwater basin via percolation ponds for subsequent extraction is evaluated using recharge basins on the east and west sides of the City. For descriptive purposes the basins are referred to as Westside and Eastside recharge pond alternatives. Both basins would be located just outside the City's sphere of influence because the 57 acres of land necessary for recharge is considerably cheaper outside the sphere of influence relative to developable land within future city limits.

Table 14 displays design factors used for recharge ponds. A conservative estimate of 1.0 ft/day for pond infiltration has been assumed over the 8-month period of water availability.[49] This yields a land requirement of 57 acres to recharge 7,000 acre-feet per year. These estimates assume a conservative 2.0 peaking (capacity) factor.

Table 14: Pond Size Requirements

	Quantity	Unit
Recharge Capacity	7,000	AF/yr
Water Availability	8	mo/yr
Peaking Factor	2.0	
Peak Recharge	1750	AF/mo
Percolation Rate	1.0	ft/day
Pond Acres Required	57	acres

Water Quality Requirements

Water quality requirements for conjunctive use projects are regulated through the RWQCB's non-degradation policy. The policy requires that recharge projects using a surface water supply shall not cause underlying groundwater to contain waste constituents in concentrations greater than background water quality.

The RWQCB will most likely not require water treatment measures (i.e. filtration or disinfection) for a recharge pond project using Mokelumne River water. Data[50,51] reviewed for the WID system suggests the Mokelumne River water is of relatively high quality, and when used conjunctively through a groundwater recharge project, will not impair the beneficial uses of groundwater within the basin.

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[49] Compare to 2.5 ft/day estimate by J.M. Lord, referenced in Section 3, WID Water Rights

[50] J.M. Lord, Incorporated, July 1991, The Lower Mokelumne River Area Crop, Soil, and Water Use Assessment for a Ground Water Storage/Conjunctive Use Study, Final Draft

[51] http://www.lodi.gov/Storm%20Drain%20Detectives/body_monthly_data.htm#MAY%202003

Westside Recharge Pond Cost Estimate

A recharge pond on the west side of the City due south of Sargent Road is shown on Figure 15. The recharge facilities would require 57 acres of land. Based on the assumptions of a percolation rate of a 1.0 foot/day with a total capacity of 7,000 acre-feet over eight months and a peaking factor of 2.0.

The facility as shown would receive source water from the WID South Main Canal at the westernmost extent of the canal near Applewood Drive. The close proximity to the canal minimizes capital and O&M costs for pipelines and pumping facilities. Table 15 shows the project level cost estimate for the Westside Recharge Pond Alternative.

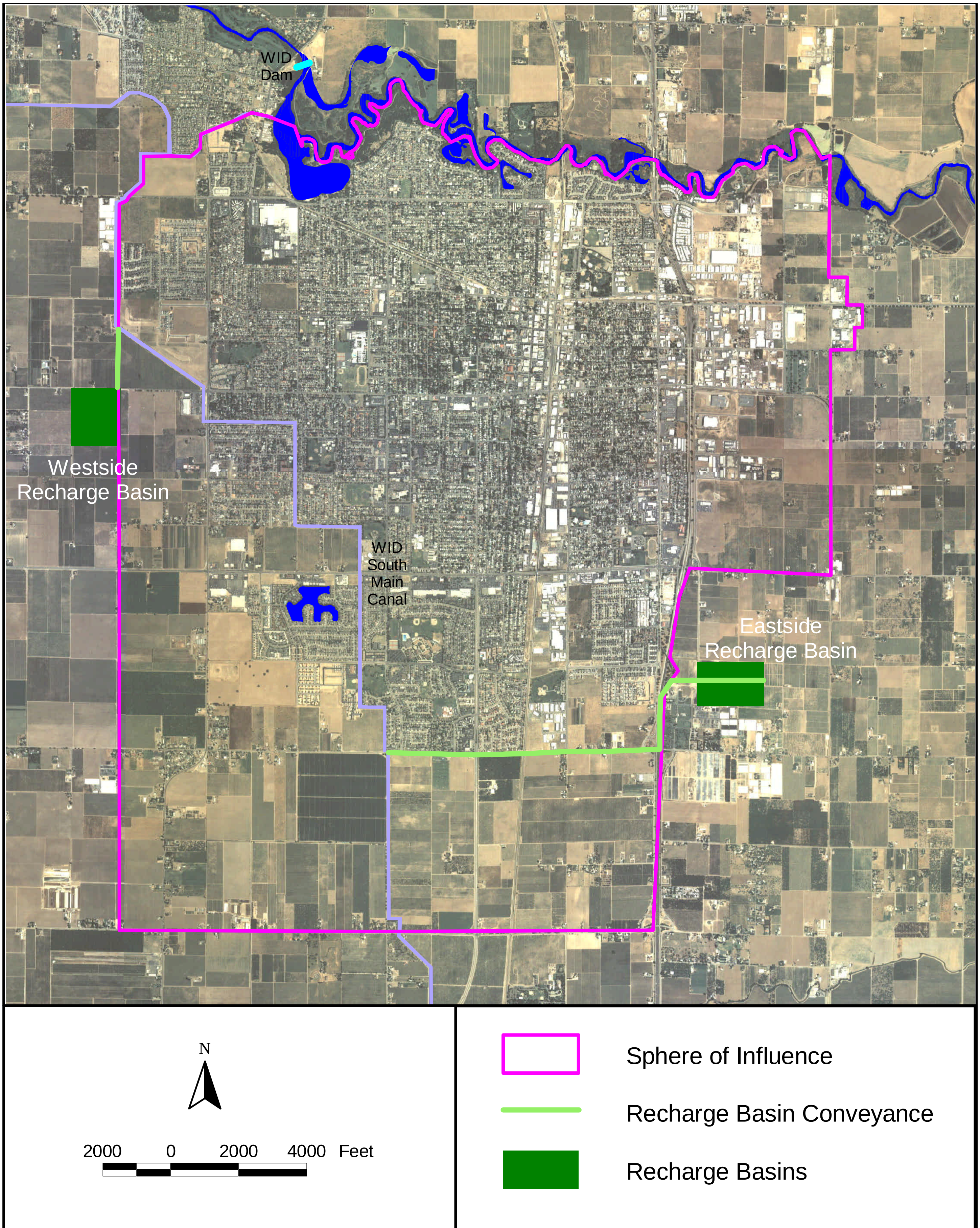
Table 15: Westside Recharge Pond Alternative

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
36" Pipeline	2,000	feet	$220	$439,000	0.5% of capital	$2,000
Recharge Basin	57	acre	$42,820	$2,440,000	4% of capital	$98,000
Land	57	acre	$30,000	$1,710,000	n/a	
Pump	30	HP	$1,710	$51,000	4% of cap + power	$12,000
30% Contingency				$1,390,000	n/a	
			Total:	$6,000,000		$112,000

Eastside Recharge Pond Cost Estimate

A recharge pond on the east side of the City just east of Highway 99 is shown on Figure 15. An east side location may be advantageous for recharging water upgradient of City extraction wells. Based on the assumptions of a percolation rate of a 1.0 foot/day with a total capacity of 7,000 acre-feet over eight months and a peaking factor of 2.0, the recharge facilities would require 57 acres of land.

The facility as shown would receive source water from the WID South Canal at the canal's intersection with Harney Lane. The conveyance pipeline would travel along Harney Lane eastward past Highway 99 before heading north. Table 16 shows the project level cost estimate for the Eastside Recharge Pond Alternative. The distance and upgradient location of this recharge pond relative to the WID South Main Canal makes this alternative more expensive relative to the Westside Recharge Alternative. The capital costs for pipelines and pumping facilities are approximately $3.4 million greater than the Westside Recharge Alternative.



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Recharge Ponds Utilizing WID South Main Canal

City of Lodi
Surface Water Supply Options

Figure 15

Date: October 2003

Prepared By: BCW

Table 16: Eastside Recharge Pond Alternative						
Facility	**Quantity**	**Units**	**Unit Cost**	**Capital Cost**	**Annual O&M Rate**	**Annual O&M Cost**
36" Pipeline	12,500	feet	$220	$2,745,000	0.5% of capital	$14,000
Recharge Basin	57	acre	$42,820	$2,440,000	4% of capital	$98,000
Land	57	acre	$30,000	$1,710,000	n/a	
Pump	200	HP	$1,710	$342,000	4% of cap + power	$79,000
30% Contingency				$2,170,000	n/a	
			Total:	$9,400,000		$191,000

Surface Water Treatment Plant and Distribution

A possible alternative of use for the WID water is to treat the water for potable uses and direct supply. The water would be available on a seasonal basis, for approximately eight months of the year. The water treatment facility is designed for a 9.5 MGD capacity, given the facility the capability to provide roughly 7,000 acre-feet of water over an eight month time period. It is assumed that the treatment plant would be run as a base loaded supply at full capacity – no peaking factor is used in this sizing. As such, only nominally sized on-site wet wells are assumed – no regulatory storage is assumed. Peak City demands would be met from groundwater.

The surface water treatment plant alternative is unique relative to all other alternatives evaluated because it would directly supply the City's distribution system with potable water. This represents in-lieu recharge by supplementing groundwater pumping with surface water supply and allowing the curtailment of groundwater use.

The majority of design assumptions for this alternative are taken from *Alternatives for Water Supply from the California Aqueduct (Parsons 2001).* The reference study evaluated numerous treatment methods for supplying California Aqueduct water directly to municipalities in the Mojave Desert. The study recommended treating the surface water utilizing a duel process of Dissolved Air Flotation (DAF) and Ultrafiltration. This process is used as an estimate for the cost of designing a similar facility in Lodi. Several other recently designed or constructed treatment plants using a variety of treatment methods were found to have similar unit construction costs.

The generalized process consists of low lift pumping from the intake location on the WID South Main Canal to prescreening facilities followed by the DAF unit. The DAF unit will remove algae, suspended solids, and protozoan pathogens such as *cryptosporidium* and *giardia*. Effluent from the DAF process would then be pumped to the Ultrafiltration membrane treatment system to remove microbial pathogens and viruses. After Ultrafiltration a disinfectant residual would be added to the treated water pursuant to California Code of Regulations, Title 22, Chapter 17, Section 64654. The treated and disinfected water would then be pumped directly in the distribution system at a pressure of 50 psi.

Water Quality Regulations

As discussed previously, the City currently relies on nondisinfected groundwater for all municipal water supply. Presently, only surface water systems and systems using groundwater under the direct influence of surface water are required to disinfect their water supplies. If the City integrates surface water into the current distribution system this would trigger regulations requiring the disinfection of all water within the system.

The City potentially could design a partially integrated or completely separate distribution system for the treated surface water, avoiding the requirement to chlorinate its groundwater supply. The limitation of the WID supply to seven-and-one-half months would add the complications of start-up At this time, the City has decided not to pursue this option and it is not evaluated further within this report.

Distribution System Disinfection

Chlorine disinfection is the most commonly practiced disinfection technology for microbial contamination of groundwater. The most common methods of chlorine disinfection include chlorine gas, sodium or calcium hypochlorite, chloramines, chlorine dioxide, or some combination of the aforementioned. Many groundwater systems that practice chlorine disinfection do so by providing a free chlorine residual at the entry point to the distribution system. The City of Sacramento uses surface water and groundwater in their distribution system. As a preventive measure the City of Sacramento disinfects groundwater at the wellhead with gas chlorine and maintains a chlorine residual in the distribution system of approximately 0.5 ppm.[52] Other less common means of disinfection include pasteurization, ozone treatment, and ultra violet light – these methods do not provide a disinfectant residual.

Proposed Groundwater Rule

The EPA is proposing a Groundwater Rule (GWR) that specifies when corrective action (including disinfection) is required to protect consumers from bacteria and viruses found in groundwater distribution systems.

[52] Personal communication, Ron Meyers, June 23, 2000

The GWR lists disinfection as a corrective action for groundwater systems that detect contamination. Through its GWR, EPA considered requiring systems to apply a disinfectant residual at the entry point to the distribution system and maintain a detectable disinfectant residual throughout the distribution system. However, EPA decided against including it in the proposed GWR since a disinfectant residual is more accepted as a distribution system tool than for controlling source water contamination. Under the proposed GWR, groundwater systems that detect microbial contamination would be required to provide 4-log (99.99%) disinfection and conduct compliance monitoring to demonstrate treatment effectiveness.

The GWR defines disinfection as the inactivation or removal of fecal microbial contamination. Chemical disinfection of viruses involves providing a dosage of a disinfectant for a period of time (the "CT") for the purposes of inactivating the viruses. For most treatment strategies, the level of inactivation achieved varies depending on the target microorganism, residual disinfectant concentration, groundwater temperature and pH, water quality and the contact time. A system compares the CT value achieved to the published CT value for a given level of treatment (e.g., 4-log inactivation of viruses) to determine the level of treatment attained. As long as the CT value achieved by the system meets or exceeds the CT value needed to inactivate viruses to 4-log, the system meets the treatment technique requirement. The City program to provide ultraviolet disinfection would meet these standards.

Cost Estimate

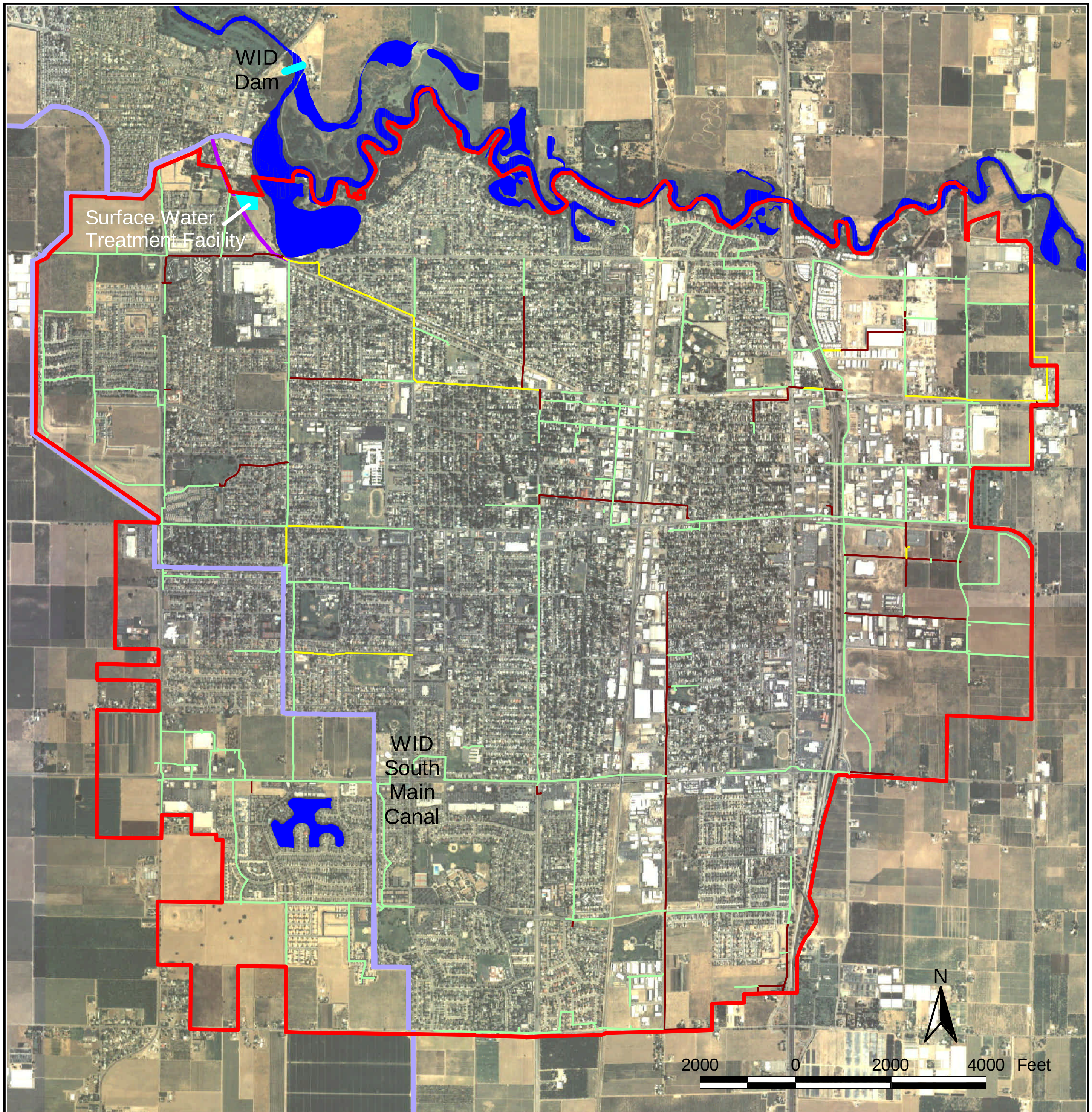
The cost estimate for this surface water treatment and distribution is presented in Table 17. The facility as sized would require a constant flow of 9.5 MGD over eight months every year to treat and deliver approximately 7,000 acre-feet of water with an estimated capital cost of $14 million and an estimated O&M cost of $800,000.

Table 17: Surface Water Treatment Plant Alternative

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
9.5 MGD Treatment Facility	9,500,000	gal/day	$1.00	$9,500,000	6% of capital	$570,000
Intake Pump	30	HP	$1,710	$51,000	4% of cap + power	$12,000
24" Intake Pipeline	1,500	feet	$146	$220,000	0.5% of capital	$1,000
Distribution Pump Station	300	HP	$1,710	$513,000	4% of cap + power	$217,000
24" Distribution Pipeline	1,500	feet	$146	$220,000	0.5% of capital	$1,000
Land	2	acre	$100,000	$200,000	n/a	
30% Contingency				$3,210,000	n/a	
			Total:	$13,900,000		$800,000

*Excludes clear well

*Excludes chlorination for entire distribution system



City Limits

Surface Water Treatment Plant

Treatment Pipeline

Large Transmission Lines

10 inch

12 inch

14 inch

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Surface Water Treatment Plant Alternative

City of Lodi
Surface Water Supply Options

Figure 16

Date: October 2003

Prepared By: BCW

Southeast Recharge Utilizing NSJWCD Facilities

The southern NSJWCD pipeline extends south from the Mokelumne River parallel to eastern boundary of City Limits approximately 2-3 miles away. The NSJWCD south pumping plant has five pumps with a combined 315 horsepower, which could provide over 50 cfs of conveyance in the southern pipeline. This flow rate is more than adequate to supply the current users of the canal while providing recharge of up to 7,000 acre-feet/year to the eastern area of Lodi. Figure 17 shows the project location, existing NSJWCD facilities, and proposed facilities to deliver recharge.

The recharge pond location used in the Eastside Recharge Pond Alternative is proposed for this alternative with a total area of 57 acres. The pipeline length from the NSJWCD south canal is approximately 13,000 feet with a 70 HP booster pump required. The capital cost of the project is $10.4 million. No estimate was made for the cost of the water, although current users are charged a flat rate of $50/acre (about $17/AF). The supply of water will be less reliable than supply from the WID South Main Canal. No regulated water supply is available from the NSJWCD canal in dry years.

Table 18: Southeast Recharge Utilizing NSJWCD Facilities

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
36" Pipeline	17,000	feet	$220	$3,733,000	0.5% of capital	$19,000
Recharge Basin	57	acre	$42,820	$2,441,000	4% of capital	$98,000
Land	57	acre	$30,000	$1,710,000	n/a	
Pump	70	HP	$1,710	$120,000	4% of cap + power	$28,000
30% Contingency				$2,401,000	n/a	
		Total:		$10,400,000		$150,000

EBMUD Banking and Large Scale Pump Back

A potential water banking agreement with EBMUD is evaluated in this alternative. As shown on Figure 17, EBMUD's Mokelumne Aqueduct would be the source of supply. Assuming operations similar to those proposed by EBMUD in the 1990s, there would be a to a two-for-one exchange between EBMUD and the City with EBMUD extracting no more than half of the water it stores at the proposed recharge basin south of the City's sphere of influence. This analysis assumes recharge of water from EBMUD's rights, but could incorporate the City's WID water. A County permit to export groundwater may be required to return water to EBMUD from outside the City's sphere of influence. Figure 17 shows a potential pipeline route for delivering water from the Mokelumne River Aqueduct to the recharge basin.

The project is sized for an average annual recharge of 6,000 acre-feet of water. The sizing is dependent on the assumption that EBMUD would only need to extract water in one out of every three years for dry-year supply with the remaining two years dedicated to recharge. To arrive at an average annual recharge of 6,000 acre-feet the project would need to recharge 18,000 acre-feet in two out of three years to allow for 18,000 acre-feet to be extracted by EBMUD for use in one year out of three. A net 18,000 acre-feet would remain in storage in the Lodi area over the three year period.

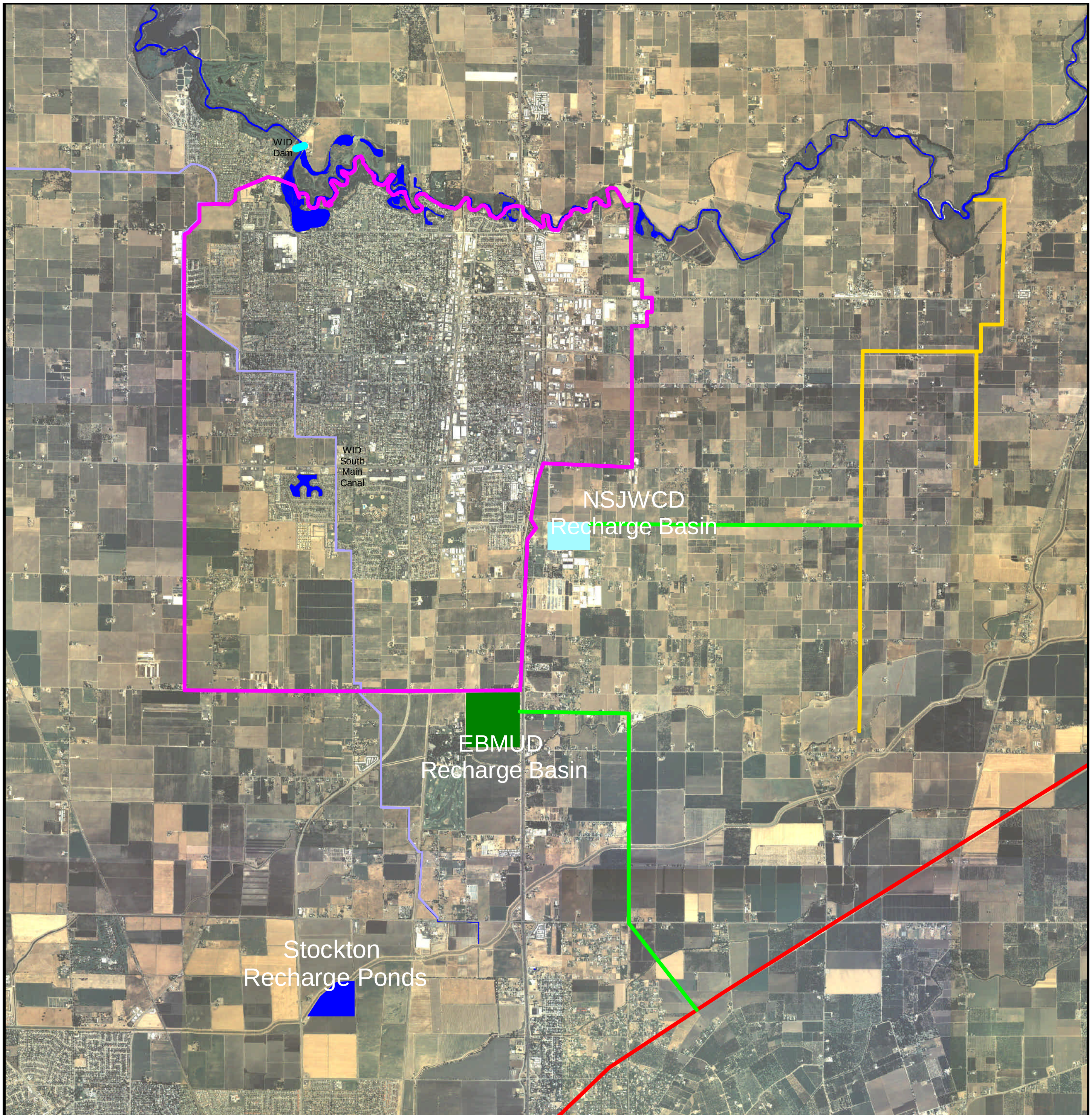
Table 19 shows the project level estimate of costs for the 18,000 acre-feet recharge and extraction facility. Unlike most alternatives evaluated, the facility is assumed to have the capability to operate during the entire year. To account for periods of maintenance and unavailable supply a peaking factor of 1.5 was included in this analysis and represented in the sizing of facilities shown in Table 19.

Table 19: EBMUD In-Lieu and Banking Potential

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
36" Pipeline	21,000	feet	$220	$4,610,000	0.5% of capital	$23,000
Recharge Basin	111	acre	$42,820	$4,740,000	4% of capital	$190,000
Land	111	acre	$30,000	$3,320,000	n/a	
Extraction Wells	10	each	$208,000	$2,080,000	4% of cap + power	$278,000
GAC Units[1]	10	each	$600,000	$6,000,000	$36,000	$360,000
Booster Pump	2,100	HP	$1,710	$3,590,000	4% of cap + power	$448,000
30% Contingency				$7,300,000	n/a	
Total:				$31,600,000[2]		$1,300,000

[1]Cost estimates from *City of Lodi Water Storage Tank Study*
[2]New extraction wells and GAC units may not be required if existing City facilities are used, lowering Total Capital Cost to $21,100,000

The pressure supplied by the Mokelumne Aqueduct will be more than sufficient to convey flow to the recharge ponds. To pump water back to the Mokelumne Aqueduct 10 extraction wells are necessary to provide for peak conveyance of 37 cfs. It is assumed that EBMUD would require granular activated carbon facilities on all extraction wells. The extraction wells can return water to the Mokelumne Aqueduct with roughly 70 feet of head, based on an initial pressure of 50 psi minus friction losses during conveyance back to the Mokelumne Aqueduct. It is assumed that the pressure in the Mokelumne Aqueduct during pump back



N

0.5 0 0.5 1 1.5 Miles

- Sphere of Influence
- NSJWCD Recharge Basin
- EBMUD Recharge Basin
- Stockton Recharge Ponds
- Possible Conveyance Facilities

Existing Regional Facilities

- Mokelumne Aqueduct
- NSJWCD South System

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Regional Alternatives

City of Lodi
Surface Water Supply Options

Figure 17

Date: October 2003

Prepared By: BCW

operations will be roughly 180 psi or 415 feet of head.[53] To supply the additional 345 feet of head required to return water to the Mokelumne Aqueduct a booster pump with roughly 2,100 HP would be necessary.

The cost of the facility is substantial relative to the alternatives previously evaluated. A project of this nature might be negotiated for EMBUD to pay most, if not all the capital and operating costs. Costs could be reduced if existing City extraction wells and GAC units are used.

Interim EBMUD Drought Contingency

The East Bay Municipal Utility District (EBMUD) and the Sacramento County Water Agency are in the process of developing the 286 cfs Freeport Regional Water Project on the Sacramento River. EBMUD's 155 cfs capacity will be conveyed to a connection point with the Mokelumne Aqueduct in San Joaquin County. The August 2003 Draft EIR/EIS anticipates project completion in 2010. For this option, Lodi would enter into a water supply contingency arrangement with EBMUD that would allow use of the WID contract supply until the Freeport supply facilities are completed. Lodi's water purchase costs could be offset, and additional proceeds from this arrangement used to construct recharge or other facilities. Water would be exchanged in-river, and EBMUD would take delivery through its existing diversion system. No capital facilities would be required.

EBMUD's average annual Freeport diversion is estimated as 23,200 acre-feet per year, with all diversion occurring in the one-third driest years. EBMUD's share of the Freeport capital construction cost is estimated at $439 million. EBMUD estimates unit operation and maintenance costs at $460 per acre-foot[54]. Unit capital repayment[55] would be about $1,480 per acre-foot of supply.

Years when EBMUD would require a supplemental supply would likely be years that WID supplies would be reduced by 35 percent, and supplies to Lodi reduced to 3,000 AF/yr. Based on EBMUD's need in the one-third driest years, the transfer to EBMUD would average 1000 AF/yr. Ways a deal might be structured include:

- If EBMUD were to pay at Lodi's cost of $200/AF, one-sixth of the WID payment would be offset for the period of the interim agreement.

[53] Boyle, 1999 Beckman Test Injection/Extraction Project
[54] March 2003 personal communication with David Bruzzone, EBMUD. Estimate based on average energy cost of $0.10/kWh
[55] Assumes 6% interest for 25 years and average annual supply of 23,200 AF/yr

- If EBMUD were to pay at the $460/AF cost of Freeport operation, 38% of the WID payment would be offset.
- If EBMUD were to pay all of the WID purchase costs on an interim basis, the unit cost of water to EBMUD would be approximately $1,200/AF, which is still in the range of EBMUD's total (O&M plus capital repayment) Freeport unit cost.

Under each of these scenarios, the WID water would be available for Lodi's use in two out of three years.

Transfer of the WID supply to an out-of-County entity would be controversial. San Joaquin County's Groundwater Export Ordinance requires a permit for transferring groundwater out of county "through direct or indirect means." It is not clear whether the Export Ordinance could be construed to apply to transfer of surface water entitlements. In any event, incorporated cities such as Lodi are not required to obtain permits under the Export Ordinance.

A variety of other projects with EBMUD might be possible. Elements could include EBMUD supplying extra wet year water in exchange for Lodi's dry year entitlements, or storage of Lodi's supply in EBMUD's reservoirs to allow year-round recharge requiring smaller capital facilities. Defining the possible permutations of such elements is beyond the scope of this study.

Interim Supply to Stockton Recharge Ponds

An interim supply of surface water to the City of Stockton is evaluated in this alternative. The WID South Main Canal terminates just north of the City of Stockton. The canal can deliver water to Bear Creek at the northern end of Stockton. Delivering water to Bear Creek via the WID canal could supply a recharge basin in northern Stockton, as shown in Figure 17.

The water supply to the City of Stockton from the City of Lodi would be a temporary agreement until the City develops recharge facilities for the WID surface water. It is assumed that the capital and operating costs of the project would be funded by the City of Stockton. As shown in Table 20, the estimated capital cost of the project is approximately $11 million. The high cost of this alternative compared to similar pond recharge alternatives can be attributed to the estimated cost of land in Stockton. The proposed recharge basin is currently located in northern Stockton with an estimated land cost of $100,000/acre. Moving the recharge basin further from City limits would reduce the total project cost to approximately $7 million if the cost of land was reduced to $30,000/acre. Utilization of existing flood detention facilities along Bear Creek might allow recharge at minimal to no cost, and could allow recovery of WID water purchase costs. Agreement with the San Joaquin County Area Flood Control Agency would be required.

Table 20: Stockton Recharge Pond Alternative

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
36" Pipeline	500	feet	$220	$110,000	0.5% of capital	$1,000
Recharge Basin	57	acre	$42,820	$2,440,000	4% of capital	$98,000
Land	57	acre	$100,000	$5,700,000	n/a	
Pump	30	HP	$1,710	$51,000	4% of cap + power	$12,000
30% Contingency				$2,490,000	n/a	
			Total:	$10,800,000		$110,000

Summary

The alternatives evaluated include surface water irrigation of parks and schools, injection of surface water, percolation of surface water, and direct surface water treatment and supply. To compare the relative cost of each alternative for utilizing a surface water supply a unit cost methodology was developed to estimate capital, operating and maintenance costs. Table 21 presents the projects sorted by the source of surface water supply. The majority of projects are designed to supply roughly 6,000-7,000 acre-feet/year of water. Projects designed to meet smaller demands include the irrigation of existing schools and parks from the WID South Main Canal and both recycled water supply options (discussed in the subsequent section). The relatively inexpensive irrigation alternatives do not have the capacity to utilize the entire WID supply, but could be combined with other alternatives to bring overall costs down.

As shown in Table 21, the most economical City-only project is the Westside Recharge Ponds. The project is located next to the source of water, the WID South Main Canal, and substantial savings are introduced by minimizing the cost of transport facilities. The most expensive projects using WID water are the injection well and surface water treatment plant options. Both projects have an estimated capital cost of roughly $14 million, although the injection well option is roughly half the cost to operate and maintain on an annual basis relative to the surface water treatment plant. Cooperative projects with the City of Stockton or EBMUD might be implemented at little or no cost to Lodi, subject to the outcome of negotiations with these entities.

Table 21: Summary of Alternatives

Project Category	Alternative	Average Water Supply (AF/year)	Estimated City Capital Cost	Estimated O&M Cost	Annualized Cost[1]	Unit Cost in $/AF of Avg. Use	Comments
Surface Water Projects with City Cost	Surface Water Irrigation of Parks and Schools	1,000	$1,400,000	$68,000	$180,000	$180	Does not maximize use of WID supply
	Injection Wells	6,000	$14,600,000	$520,000	$1,660,000	$280	Small amount of surface area required; provides direct recharge; high operation and maintenance costs; requires dispersed network of injection and extraction wells
	Westside Recharge Pond	6,000	$6,000,000	$112,000	$580,000	$100	Most economical; land available; suitable infiltration rates
	Eastside Recharge Pond	6,000	$9,400,000	$191,000	$930,000	$160	Recharge located in area of lowest GW levels; land available; suitable infiltration rates
	Surface Water Treatment Plant	6,000	$13,900,000	$800,000	$1,890,000	$320	Provides in-lieu groundwater recharge; disinfection of entire distribution system required; needs base line supply
	Recharge Utilizing NSJWCD Facilities	6,000	$10,400,000	$150,000	$960,000	$160	Recharge located in area of lowest groundwater levels; land available; additional capacity using NSJWCD supply
Regional Projects with Shared or No City Cost[2]	Stockton Interim Recharge Ponds	6,000	$0 to $10,800,000	$0 to $110,000	$0 to $950,000	$0 to $160	Interim project to offset WID purchase costs; use of flood control facilities could reduce cost
	EBMUD In-Lieu and Banking Potential	6,000	$0 to $31,600,000	$0 to $1,300,000	$0 to $3,770,000	$0 to $630	Recharge located in area of lowest GW levels: cost sharing opportunities; water export may be controversial
	EBMUD In-River Exchange	0[5]	$0	$0	$0	net revenue generator	Interim revenue generation option. Average supply to EBMUD 1,000 AF/yr, leaving 5,000 AF/yr for local recharge
Recycled Water Projects with City Cost	White Slough Recycled Water Return[3]	2,000	$4,700,000	$98,000	$470,000	$240	No new cost for water; funding assistance may be available; public perception issues;
	Scalping Facility[3,4]	2,000	$14,600,000	$700,000	$1,840,000	$920	No new cost for water; funding assistance may be available; public perception issues

[1] Capital repayment based on a 25-year payback period with 6% interest; Table does not include the price of water
[2] Range of costs reflects to-be-negotiated cost sharing
[3] Excludes non-potable distribution system and regulating storage
[4] Excludes offsetting benefit of operation delayed expansion of White Slough WPCF
[5] 3,000 AF of WID supply transferred to EBMUD in 1/3 of years

Section 6. Recycled Water Options

Background

The City of Lodi Public Works Department operates the White Slough Water Pollution Control Facility (White Slough WPCF), located six miles to the southwest of the Lodi service area. The facility has the capacity to treat up to 8.5 MGD (9,500 acre-feet/year) of wastewater. White Slough WPCF currently treats an average of 6.6 MGD (7,400 acre-feet/year)[56].

The current level of treatment at White Slough WPCF is conventional activated sludge secondary treatment and chlorine gas disinfection. Primary and secondary solids are further treated in anaerobic digesters and a biosolids lagoon. The majority of secondary treated effluent is discharged either to surface water (Dredger Cut) or used for agricultural irrigation of animal feed crops on adjacent City land. Tertiary treatment facilities to treat water to Title 22 standards are currently under construction. Surface waters currently receive disinfected secondary effluent and animal feed crops receive a mixture of non-disinfected secondary effluent, digested biosolids, and industrial wastewater. A small amount of treated effluent is used adjacent to the treatment plant for the Mosquito Abatement District fish ponds and the NCPA Power Plant.

Objective

The objective of this report section is to provide a framework for future decision-making regarding recycling options for tertiary treated effluent within the City's service area. After completion of the tertiary treatment facilities, the City is planning to discharge tertiary effluent to surface waters when necessary, while continuing to irrigate animal feed crops with non-disinfected secondary effluent. This operation may be the most economical use of treated effluent in the near-term, but increasing demands on groundwater and increasing surface water discharge regulations may provide future incentive for water recycling within the City's service area. This section reviews the recycling options available to the City, the potential pathways for financial support associated with capital improvements, and the current water quality regulations for recycled water projects.

[56] Lodi Urban Water Management Plan (UWMP), 2001

Recycling Options

Recycling treated municipal wastewater has been practiced since the early 1900s as one option to efficiently manage water resources. The Water Recycling Task Force 2003 (WRTF), created by Assembly Bill 331 to identify opportunities for increasing the use of recycled water, estimated that California currently recycles between 450,000 to 580,000 acre-feet per year. The WRTF determined that California has the potential to recycle up to 1.5 million acre-feet/year of water by the year 2030. The most common recycling options include the following:

- Landscape irrigation of highway medians, golf courses, parks, schoolyards and residential homes
- Agricultural uses such as irrigation of produce, pastures for animal feed, and nursery plant products
- Industrial uses such as power station cooling towers, oil refinery boiler feed water, carpet dying, and recycled newspaper processing
- Groundwater percolation

While the City currently recycles secondary treated effluent for agricultural irrigation of animal feed crops, tertiary treated effluent has a much broader set of uses, including applications within the City's service area. Table 22 displays the minimum level of treatment for various recycling options as determined by the California Department of Health Services (DHS).

Future Recycled Water Demand

Irrigating residential and commercial landscapes with recycled water can decrease new demands for potable water. Typical uses for tertiary treated recycled water include irrigation of residential landscapes, street medians, golf courses, parks, and schoolyards. In most cases using recycled water in residential and commercial areas will require dual plumbing.

This analysis assumes that only future facilities and residences would receive dual plumbing for recycled water use. It is assumed that retrofitting existing facilities with dual plumbing would be prohibitively expensive and would lack an adequate funding source. The marginal cost of such a system would be substantially less if installed together with a potable water system in newly developed areas. Cost sharing options for installing dual plumbing during the construction of future facilities is discussed in a subsequent section.

Table 22: Examples of DHS Minimum Treatment Levels

Adapted from Water Recycling 2030, Recycled Water Task Force

	Minimum Treatment Level		
Types of Use	Disinfected Tertiary	Disinfected Secondary	Non-disinfected Secondary
Urban Uses and Landscape Irrigation			
Fire protection	X		
Toilet & Urinal Flushing	X		
Irrigation of Parks, Schoolyards, Residential Landscaping	X		
Irrigation of Cemeteries, Highway Landscaping		X	
Irrigation of Nurseries		X	
Landscape Impoundment	X	X*	
Agricultural Irrigation			
Pasture for milk animals		X	
Fodder and Fiber Crops			X
Orchards (no contact between fruit and recycled water)			X
Vineyards (no contact between fruit and recycled water)			X
Non-Food Bearing Trees			X
Food Crops Eaten After Processing		X	
Food Crops Eaten Raw	X		
Commercial/Industrial			
Cooling & Air Conditioning - w/cooling towers	X	X*	
Structural Fire Fighting	X		
Commercial Car Washes	X		
Commercial Laundries	X		
Artificial Snow Making	X		
Soil Compaction, Concrete Mixing		X	
Environmental and other Uses			
Recreational Ponds with Body Contact (Swimming)	X		
Wildlife Habitat/Wetland		X	
Aquaculture	X	X*	
Groundwater Recharge			
Seawater intrusion Barrier	X*		
Replenishment of potable aquifers	X*		

* Restrictions may apply

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Table 23 displays an estimation of future water demand within the City's service area that could be satisfied with recycled water. To estimate future demand supported by recycled water it is assumed that all new single family residential households constructed between 2005 and 2020 would use recycled water for landscape irrigation of front and back yards. *Table 3-1 of the City's 2001 UWMP* estimates approximately 4,000 residential households will be constructed between 2005 and 2020. Total residential recycled water demand was estimated based on the 4,000 residential households and a recycled water unit use rate based on El Dorado Irrigation District (EID) data.

Table 23: Future Potential Recycled Water Demand 2005 - 2020

Land Use	Quantity	Recycled Water Use Factor	Annual Recycled Water Demand (AF/yr)
Residential Households	4,000 dwelling units	0.32 acre-feet/yr/du	1,280
Parks	42 acres	3.0 acre-feet/yr/acre	130
Greenbelt Corridors	120 acres	3.0 acre-feet/yr/acre	360
Schools	30 acres	2.0 acre-feet/yr/acre	60
Public/Quasi Public[1]	34 acres	2.0 acre-feet/yr/acre	70
Total			1,900

[1] Includes government owned facilities, public and private schools, hospitals, and churches

The EID currently has 1,300 dual plumbed residential connections that irrigate front and back yards with recycled water. The average lot size of these residences is roughly 0.2 acres.[57] Based on historic metering data, the *Recycled Water Master Plan for the El Dorado Irrigation District, 2002* concluded that the average annual use of recycled water for their dual plumbed residential dwelling units is 0.42 acre-feet/year. The City of Lodi's *Westside Facilities Master Plan, 2001* estimates the average lot size of planned residential units is 0.15 acres, roughly 75% of the average lot size of dual plumbed EID residences. EID's recycled water use rate of 0.42 acre-feet/year/residence was adjusted to 75% to reflect the difference in average lot size. Applying a rate of 0.32 acre-feet/year/residence to Lodi yields approximately 1,280 acre-feet/year of potential residential water demand that could be satisfied with recycled water.

The City's *Westside Facilities Master Plan, 2001* was consulted to estimate potential recycled water demand from new parks, greenbelt corridors, schools, and public/quasi public areas. The *Westside Plan* proposes a development of 1,331 residential units, which is approximately one-third of the 4,000 residential households assumed to be constructed between 2005 and 2020 in the UWMP. Assuming that the ratio of land uses to residential households found in the *Westside Plan* is typical for all new development within the City, the

[57] Personal Communication with EID engineer Cindy Megerdigian (September, 2003)

areas of land capable of receiving recycled water in the *Westside Plan* were tripled to calculate total acreages of new parks, schools, etc. Average water demands for parks and schools was calculated from 2001 water meter data provided by the City. Water demand for public/quasi public land and greenbelt corridors is estimated at 2.0 and 3.0 acre-feet/year, respectively.

Estimates displayed in Table 23 show that the City could potentially use 1,900 acre-feet of recycled water for various landscaping irrigation purposes. Recycled water use potential is thus about a third of the WID supply. Recycled water options included in this report have been sized to accommodate a nominal 2,000 acre-feet of demand to provide flexibility in implementation.

Balance Between Recycled Water Demand and Supply

The recycled water demand estimate is based primarily on landscape irrigation needs for new development. Typical demands for landscape irrigation in California occur during the fall, spring, and summer. Table 24 displays an estimate of monthly recycled water demand[58] as a percentage of annual demand. The monthly volume of recycled water demand shown in Table 24 is based on the estimated annual demand of 2,000 acre-feet. As shown in the table, the highest demands occur during the summer months to satisfy irrigation needs. The peak monthly demand for potential recycled water occurs in July, with an estimated demand of 408 acre-feet.

Table 24: Demand Variability of Recycled Water From New Development

Month	Percent of Annual Demand[1]	Monthly Demand (AF)	Daily Demand (AF)	Daily Demand (MG)	Hourly Demand 9 hour irrigation (MG)
January	2.0%	41	1.3	0.43	0.05
February	3.0%	60	2.2	0.70	0.08
March	5.1%	103	3.3	1.08	0.12
April	7.2%	144	4.8	1.56	0.17
May	10.2%	204	6.6	2.15	0.24
June	15.1%	302	10.1	3.28	0.36
July	20.4%	408	13.2	4.29	0.48
August	17.4%	348	11.2	3.66	0.41
September	10.2%	204	6.8	2.22	0.25
October	5.1%	103	3.3	1.08	0.12
November	2.0%	41	1.4	0.44	0.05
December	2.0%	41	1.3	0.43	0.05

[1]EID Recycled Water Master Plan

[58] El Dorado Irrigation District (EID) Recycled Water Master Plan (2002)

Table 24 also displays estimates for potential daily and hourly recycled water demand. Current recommendations for recycled water suggest that all spray irrigation occur during the hours with the minimum opportunity for public contact. EID requires dual-plumbed residential customers to irrigate with recycled water between the hours of 9:30 p.m. and 6:30 a.m.[59] This analysis assumes that all recycled water demand occurs during a similar 9-hour period.

While irrigating with recycled water at night provides an additional level of safety for the public it creates a discrepancy between supply and demand. Wastewater treatment plants typically receive the highest flows during the day and the lowest flows during the night. Consequently, to satisfy all recycled water demand occurring at night some level of distribution storage is needed. Approximately 2-3 million gallons of storage for recycled water would be needed to satisfy peak demands, based on the rough estimate described below.

The 2001 UWMP estimates an average annual wastewater flow in 2020 of 8.5 MGD[60], which includes industrial flows. It is assumed that all industrial flows, which are predominantly cannery waste containing high levels of solids and organics, would not be treated for in-city use. Subtracting out maximum industrial flows of roughly 450 MG[61] to the 2020 UWMP estimate yields an average annual wastewater flow of 7.25 MGD. Assuming this flow is constant throughout the year equates to an average hourly inflow of .30 MG. Assuming nighttime flow rates equal two thirds of daytime rates[62], an estimated 1.8 MG of inflow would occur during the 9-hour period between 9:30 p.m. and 6:30 a.m. As shown in the Table 24, the peak hourly demand of 0.48 MG/hour occurs in July. Extending this over 9 hours equates to 4.3 MG. Based on these estimates, a 2.5 MG discrepancy exists between supply and demand and would need to be made up from distribution storage.

Recycled Water Options

Two options are considered in this report to use recycled water within the City's service area: (1) a return pipeline constructed from White Slough WPCF to convey tertiary treated effluent back to the City; and (2) a "scalping facility" constructed near the City limits to treat a portion of the flow headed to White Slough WPCF while returning solids and some liquid to the White Slough pipeline for final treatment and disposal.

[59] Personal Communication with EID engineer Cindy Megerdigian (September, 2003)
[60] Excludes cannery flows
[61] West Yost & Associates, Wastewater Master Plan (2001)
[62] Based on the Master Plan peaking factor of 1.5

The cost of recycled water distribution and diurnal storage within the City's service area is not evaluated because it is assumed the cost would be similar for both alternatives. For comparison purposes both options are evaluated based on each providing tertiary treated recycled water in the southwest corner of the City with a distribution pressure of 50 psi.

Recycled Water Return from White Slough WPCF

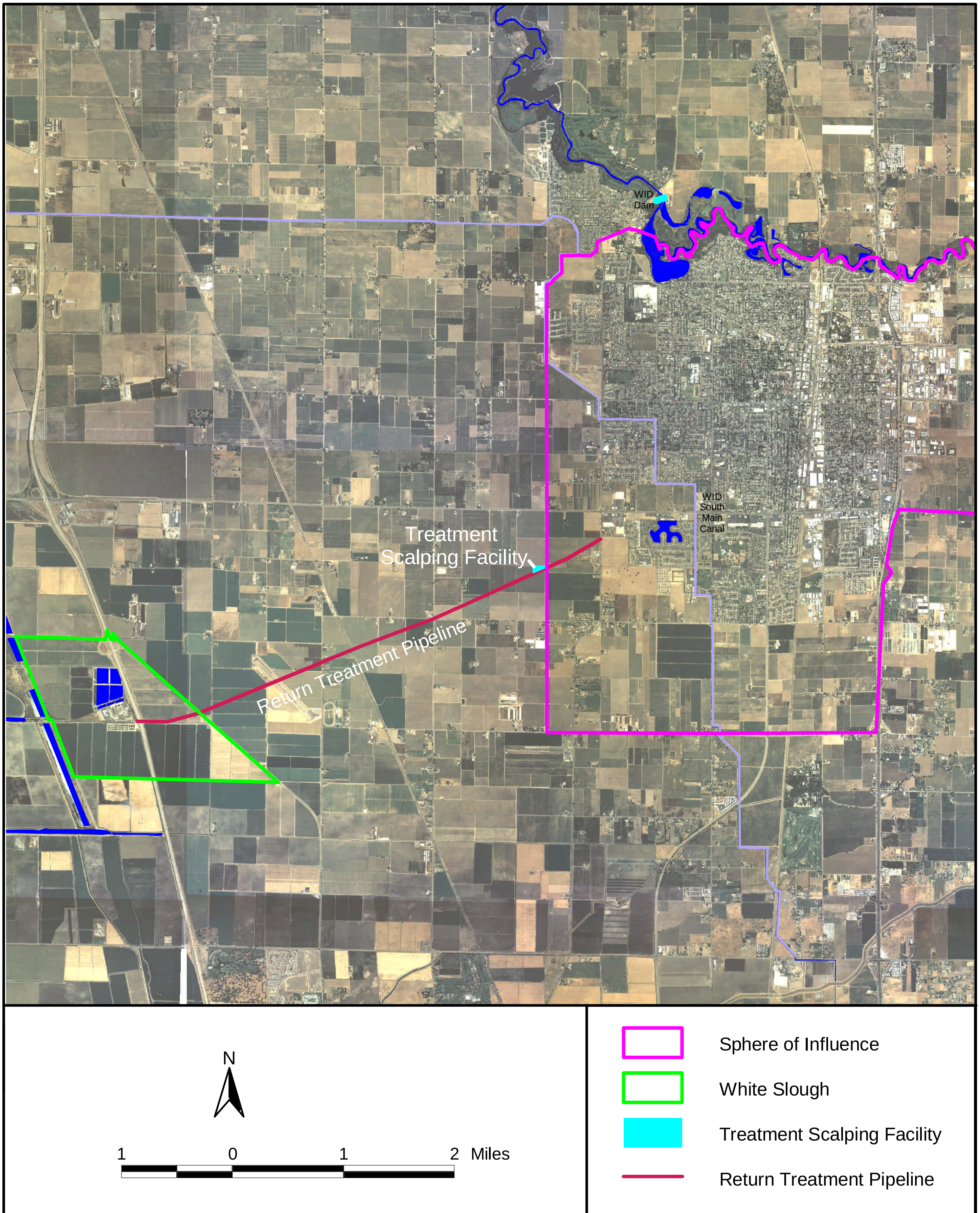
Unit costs described previously in this report was applied to the White Slough return pipeline to evaluate the current capital cost of constructing the project. The analysis assumes a pipeline length of 27,500 feet with a diameter of 18 inches based on an average annual demand of 2,000 acre-feet. A pumping station with 350 horsepower is included to return flow to the City's service area with a distribution pressure of 50 psi. Figure 18 displays the pipeline route from White Slough to the City service area. The analysis estimates a capital cost for returning recycled water to the City service area of $4.7 million. In addition to capital cost an annual O&M cost of approximately $98,000 would be incurred to return the recycled water from White Slough WPCF.

Table 25: White Slough Recycled Water Return

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
18" Pipeline	27,500	feet	$110	$3,020,000	0.5% of capital	$15,000
Pump Station	350	HP	$1,710	$599,000	4% of cap + power	$83,000
30% Contingency				$1,086,000		
			Total:	$4,700,000 *		$98,000

*Excludes distribution system and regulating storage

West Yost & Associates (WYA) provided the City with a project level cost estimate in 2000 for a return pipeline for recycled water from White Slough WPCF. WYA provided two estimates based on 27,500 feet of pipe conveying (1) the full treatment capacity of White Slough; and (2) approximately half of the treatment capacity of White Slough. The WYA cost estimate for the facility conveying approximately half of the treatment capacity of White Slough WPCF would approximately 4.25 MGD of conveyance, or the approximate peak month (July) demand for recycled water. WYA estimates a total capital cost of $5.4 million for installing pumping facilities and pipeline.



Saracino·Kirby·Snow
A Schlumberger Company

Recycled Water Options

City of Lodi
Surface Water Supply Options

Figure 18

Date: October 2003

Prepared By: BCW

Scalping Facility Treatment

A scalping facility near the City limits would negate the need to return recycled water from White Slough via a pipeline and pumping station. Figure 18 shows the location of a potential scalping facility constructed near the City limits to treat a portion of the flow headed to White Slough WPCF. The scalping facility would intercept wastewater flow headed to White Slough WPCF and treat the majority of liquid water while returning solids and some liquid to the White Slough pipeline for final treatment and disposal. The scalping facility would be designed to treat to tertiary standards for landscape irrigation purposes.

Table 26 displays the project level cost estimate for the scalping facility. Based on peak July demand, the scalping facility would need a capacity of 4.3 MGD. The unit cost for such a scalping facility is approximately $2.50 per gallon/day of capacity for capital construction.[63] Typical wastewater treatment plants cost approximately $5.00 per gallon/day of capacity, but scalping the liquids and avoiding the need for a sludge treatment process reduces the capital cost by half. The distribution pump station includes a 140 horsepower pumping facility to provide 50 psi to the receiving distribution system.

As shown in Table 26, a scalping facility would cost approximately $14.6 million to construct with an annual O&M cost of $700,000. This cost estimate does not take into account the cost savings from decreased use of White Slough WPCF for wastewater treatment nor does it consider the benefits of expanding the overall treatment capacity of the City's wastewater treatment system – both of these factors are significant and will require additional analysis beyond the scope of this study.

Table 26: Scalping Facility Costs

Facility	Quantity	Units	Unit Cost	Capital Cost	Annual O&M Rate	Annual O&M Cost
4.5 MGD Scalping Facility[a]	4,300,000	gal/day	$2.50	$10,750,000	6% of capital	$645,000
Distribution Pump Station	140	HP	$1,710	$239,000	4% of cap + power	$55,000
15" Distribution Pipeline	1,500	feet	$92	$137,000	0.5% of capital	$1,000
Land	3	acre	$30,000	$90,000	n/a	
30% Contingency				$3,360,000		
			Total:	$14,600,000 *		$700,000

[a]Unit cost estimate developed from phone conversation with Brown and Caldwell (Tom Mingee)

[b]Does not account for cost savings of White Slough WPCF operation nor capacity increase benefits.

*Excludes distribution system and regulating storage

[63] Phone conversations with Brown and Caldwell, Tom Mingee, August 2003

Potential Funding Mechanisms

State and Federal Sources

Water recycling projects are typically more expensive compared to alternative local water supplies and state and federal agencies are more willing to provide subsidies for capital costs. The Water Recycling Task Force (WTRF) 2003 noted a precedent for state or federal subsidy of water projects when a particular project has financial difficulties and there are social, economic, and/or environmental goals included within the project. State funding is typically in the form of low interest loans or partial grants for planning, design, and construction of projects. Federal funding is typically in the form of partial grants for design and construction.

Historically the sources of state funding have been bond issues, the most recent of which is Proposition 50, which includes $180 million for water use efficiency projects, including water recycling.[64] Table 27 displays the forecasted funding available for local assistance[65] with water recycling projects as administered under the following SWRCB programs:

Table 27: Forecasted Prop 50 Water Recycling Funds for Local Assistance

Fiscal Year	Dollars (millions)
2002-2003	$10.0
2003-2004	$25.5
2004-2005	$16.5
Total	$52.0

Water Recycling Facilities Planning Grant Program – The program provides grants up to $75,000 to local public agencies to investigate the feasibility of water recycling and to prepare a facilities plan. The planning grant requires a 50% local match.

Water Recycling Construction Program - The program provides low-interest loans and grants to local public agencies for the design and construction of water recycling facilities. The types of facilities include wastewater treatment, recycled water storage facilities, pump stations, and recycled water distribution pipelines. A funding application must include a facilities plan to document the need for the project, the alternatives that were analyzed, and the engineering, economic, financial, and institutional feasibility of the proposed facilities.

[64] Proposition 50 Section 79550 (g)
[65] March 2003 Presentation by Diana Robles, Chief, Office of Water Recycling, SWRCB

Private Sources

An option besides funding from state and federal agencies is private investment. The El Dorado Irrigation District (EID) recently partnered with the El Dorado Hills Development Company (EDHDC) in an effort to minimize EID's potable water demand. To maximize the use of recycled water the EDHDC dual-plumbed the Serrano development in El Dorado Hills with potable and recycled water lines. The recycled water lines are used for golf course irrigation, street median landscaping, park landscaping, and residential landscaping.

EDHDC paid for all capital costs associated with upgrading EID's treatment and delivery facilities to tertiary standards in lieu of facility capacity charges. Additionally, EDHDC pays for all O&M and power costs in lieu of paying a monthly use charge. As part of the agreement EDHDC was given priority rights for the recycled water. EID benefits from the agreement by reducing surface water discharge, which under their permit with the RWQCB requires a higher level of treatment compared to the treatment requirements for Title 22 recycled water for unrestricted use.

The City and future development could pursue a similar agreement to offset capital and O&M cost, which would likely work best with larger development projects.

Water Quality Requirements and Regulations

Landscape Irrigation

The water quality requirements of recycled water depend upon the use of the water. Typical uses of recycled water in the City's service area for landscape irrigation would require compliance with Title 22 Reclamation requirements, including tertiary filtration and disinfection. The facility upgrades to White Slough WPCF, scheduled for completion in the fall of 2004, will provide the ability to treat to the disinfected tertiary level as defined by Title 22, Section 60301.[66]

The following requirements found in the EID Recycled Water Master Plan (2002) apply for landscaping irrigation using recycled water:

[66] (1) A disinfection process that, when combined with the filtration process has been demonstrated to inactivate and/or remove 99.999 percent of the plaque forming units F-specific bacteriophage MS2 in the wastewater. (2) The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed a Maximum Probable Number (MPN) of 2.2 per 100 milliliters utilizing the bacteriological results over seven days.

- No irrigation with recycled water shall take place within 50 feet of any domestic water supply.
- Irrigation runoff shall be confined to the recycled water use area.
- Spray, mist, or runoff shall not enter dwellings, designated outdoor eating areas, or food handling facilities.
- Drinking water fountains shall be protected against contact with recycled water spray, mist, or runoff.
- All use areas with public access shall be posted with signs that are visible to the public.
- No physical connection shall be made or allowed to exist between any recycled water system and any separate system conveying potable water.

Groundwater Recharge with Recycled Water

The California Department of Health Services (DHS) requires advanced treatment of recycled water before it is used to recharge groundwater aquifers. The DHS currently has draft regulations for the recharge of groundwater with recycled water but no final regulations are drafted at this time. Consequently, DHS has directed the RWQCBs to consider recycled water projects on a case-by-case basis referring to the published codes and laws regulating recycled water. Laws regulating recycled water are contained in the following:

- California Water Code Title 17 Section 7583 et seq. dealing with cross-connection control
- California Water Code Title 22 Sections 60313-60616 dealing with recycled water dual plumbed systems
- California Plumbing Code (CPC) Sections 601.2.2 and 601.2.3 and Appendix J dealing with dual plumbed systems

The following is a summary of the general water quality recommendations for recycled water recharge projects as outlined by DHS.[67]

1. The recycled water shall meet the definition of disinfected tertiary recycled water.
2. For a surface spreading project, all the recharge water shall be retained underground for a minimum of six months prior to extraction for use as a drinking water supply, and shall not be extracted within 500 feet of a point of recharge.

[67] Draft Regulations (7-21-03) Title 22, California Code of Regulations Division 4. Environmental Health Chapter 3. Recycling Criteria

3. For a subsurface injection project, all the recharge water shall be retained underground for a minimum of nine months prior to extraction for use as a drinking water supply, and shall not be extracted within 2000 feet of a point of recharge.
4. The total nitrogen concentration of the recycled water, or if supplemented with diluent water, the blend of the two, shall not exceed the total nitrogen level specified by DHS on review of historical nitrogen data and other operational data.
5. The recycled water shall be in compliance with the following:
    - Primary and secondary maximum contaminant levels
    - MCLs for disinfection byproducts
    - Action levels for lead and copper
    - Total organic carbon (TOC) in any portion of the filtered wastewater that is not subsequently treated with reverse osmosis shall not exceed 16 mg/L for more than two consecutive samples.

Summary

The City is currently designing tertiary treatment filtration facilities at the White Slough Water Pollution Control Facility capable of producing Title 22 recycled water that meets water quality regulations for landscape irrigation of residential homes, golf courses, parks, schoolyards, and commercial areas. This report estimates the City could potentially use 2,000 acre-feet of recycled water at buildout for various landscaping irrigation purposes. This estimate is based on a water demand analysis assuming only future facilities and residences would receive dual plumbing and thus the means to irrigate with recycled water.

Two options are considered to use recycled water within the City's service area; (1) a return pipeline constructed from White Slough WPCF to convey tertiary treated effluent back to the City; and (2) a "scalping facility" constructed near the City limits to treat a portion of the flow headed to White Slough WPCF while returning solids and some liquid to the current White Slough pipeline for final treatment and disposal. The estimated capital cost of the return pipeline option is $4.7 million. The estimated capital cost of the scalping facility is $14.6 million.

Public funding assistance for recycled water projects are typically in the form of bond issues, the most recent of which is Proposition 50. Approximately $42 million in water recycling funds for local assistance is available through Proposition 50 for fiscal years 2003-2004 and 2004-2005. Private funding assistance is also available in some cases. Under one possible scenario a developer would absorb the capital and O&M costs for facility installation and upgrading in exchange for development rights and reduced facility capacity charges.

Section 7. Mitigations for New Development

New developments add additional demand on local water resources and require the construction of additional facilities to accommodate this demand. Water suppliers can develop mitigation requirements for new developments to help offset these impacts. For this task, the practices of several northern California municipal utilities are reviewed and compiled to list potential requirements that City could reasonably require of developers to offset these impacts. The Urban Water Management Plans for the Stockton East Water District (SEWD), East Bay Municipal Utility District (EBMUD), and the cities of Lodi, Davis, Lincoln, and Stockton, California were reviewed for mitigations required for new developments. Additional information was gathered from the cities of Manteca, Tracy, and Modesto, and from the El Dorado Irrigation District. The mitigations practiced and enforced by each of these entities are summarized into a listing of applicable mitigation alternatives that might be considered for implementation by the City of Lodi to offset cost of its new surface water supply.

Identified measures fall into four broad categories:

- Water use efficiency programs and metering
- Funding and construction of water supply infrastructure
- Reclamation and dual plumbing requirements
- Building code and landscaping requirements

Water Use Efficiency Programs and Metering

Programs to increase water use efficiency include plumbing modifications as well as changing water use habits. Plumbing modifications include installation of low-flow fixtures and appliances. Water use practices include metering, pricing, and irrigation restrictions.

The City's current water use efficiency measures include enforcement of yard watering restrictions, in-school education programs, public information and education programs, building code enforcement, and promotional programs such as rebates for purchase of water efficient fixtures.

Requirements for new developments might include:

- Metering. The primary mitigation that should be considered for new developments is the metering of water use. Existing law requires the installation of a water meter as a condition of water service provided pursuant to a connection installed on and after January 1, 1992[68]. Water use in the City of Davis was approximately 20 percent higher prior to the switch to metering in the mid-1990s. Metering can also aid in identifying leaking pipes or damaged irrigation systems[69], which can lead to reduced losses. According to the 2001 City of Lodi Urban Water Management Plan (UWMP), metering with commodity rates for all new connections has been studied and found to be cost effective, but has not yet been implemented.

  In addition to metering all new connections, the City might consider the following methods to accelerate the retrofit of meters for current users:
  - mandatory metering of commercial facilities
  - voluntary meter program – early adopters generally are those who use less than average and can thus realize reduced water charges
  - meters for luxury uses (e.g. swimming pools)
  - meter on pipe/lateral replacement
  - meter at change of ownership[70]

  An additional consideration to make metering an effective water conservation tool is to make the volume-base charge a significant portion of a customer's water bill. If the capacity (meter) charge is a large part of the bill, the customer will not see a large incentive to cut water use. Similarly, adding other charges to the water bill such as wastewater fees will also dilute the incentive to conserve. On the other hand, adopting a wastewater fee tied to the volume of water used will accentuate the incentive to conserve. A drought reserve fund might be established to stabilize water utility revenues.

- Submetering. Require the use of separate meters to indicate individual water use in apartments, condominiums, and trailer homes to promote water awareness by individual users that might otherwise be metered only for the complex as a whole. Submetering is reported to reduce water usage by 20 to 40 percent. Retrofitting existing structures may be expensive, but is relatively easy in new construction.

[68] California Water Code, General Provisions, Chapter 8, Article 3, Section 523
[69] The City of Davis has installed billing software that automatically sends a notice to homeowners if a significant increase in water use is detected, e.g. from a damaged irrigation system
[70] The City of San Diego, City of San Francisco, City of Santa Monica, Monterey Peninsula Water Management District, and North Marin Water District have plumbing retrofit on resale ordinances (http://www.owue.water.ca.gov/urbanplan/faq/faq.cfm)

- Increasing block rate pricing. This rate structure reduces water use by increasing per-unit charges as the amount used increases.

- Automatic irrigation systems. Timed irrigation systems are required for all new single-family homes in the City of Lincoln. Soil moisture sensing irrigation systems save water by balancing the needs of the plant and shutting down during periods of rain. Such a mitigation could be implemented by Lodi for all new developments in conjunction with a discount or incentive program for drought-tolerant landscaping. Currently, EBMUD has a system in place that rewards public and commercial entities with discounted meter and connection fees when landscapes are installed that do not need irrigated water within three years of installation. The City of Lodi's demonstration garden is a good start in promoting low-water use landscaping.

- Conservation retrofit programs. The City could collect fees that would fund meter retrofit, efficient fixture, turf-replacement, water audits, and other programs for older portions of the City. For example, a new development with a water demand of 10 acre-feet per year could be charged a fee adequate to develop 10 acre-feet of conserved water savings[71]. Developer fees could similarly fund leak detection and repair programs for the existing water system. One consideration for Lodi is evaluation of the net increase in water demand for parcels that have been converted from agricultural to residential use.

Turf Replacement Incentives

The Southern Nevada Water Authority instituted a "cash for grass" program in 1999 that provides an incentive payment for replacement of turf grass with low water use landscaping. At the going rate of one dollar for every square foot of grass removed, interest has been high.

Funding and Construction of Water Supply Infrastructure

A philosophy of water supply planning that is growing in application is the principle that "growth pays for growth," in other words, the cost to serve new development should be paid for by such development, rather than distributed throughout the rate base.

[71] For example, if expected savings from metering is 20%, a developer might be required to retrofit five houses with meters for each new unit constructed.

In the extreme, each user might be charged the precise cost for the facilities to pump, treat, and deliver water to the point of connection. In practice, utilities designate zones of benefit with similar characteristics and collect the same fees for each connection within the zone. For example, the East Bay Municipal Utility District uses nine zones for its 325-square mile territory. These zones are differentiated by the major facilities required to serve them.

Designation of service zones might be accomplished during a master planning process, during development of an Urban Water Management Plan, or as part of a Capital Improvement Plan process. All areas that will benefit from a new facility (e.g. a pumping plant or pipeline) should share in the cost of that facility. Likewise, a new increment of demand that requires development of a new supply (e.g. a new well, or imported water supply) should pay for the cost of acquiring and developing that supply.

City of Tracy

The population of rapidly growing Tracy has been increasing at more than eight percent per year. Surface water from the federal Delta-Mendota Canal supplemented by nine groundwater wells supplies the City. As a condition for receiving federal water, all water use is metered. Projected growth and hard groundwater lead to the City's participation in the South County Surface Water Supply Project for a secondary source of supply for up to 10,000 acre-feet. The City is installing a dual distribution system in anticipation of using recycled water in the future. The City is divided into assessment districts and the cost of supply infrastructure reimbursed from developments based on water demand

(Linda Moniz, City of Tracy)

For facilities that serve a single development, or limited geographic area, the developer might be compelled to design, permit, and construct the facility as a condition of development. For water facilities, ownership is most often turned over to the local water supply agency for maintenance and operation.

In addition to a meter installation charge, the fee structure for new developments could include the following components:

- a connection fee to recover appropriate costs of the existing production system
- a water capacity charge to cover acquisition and development of new supplies and to recover infrastructure costs such as new pipelines and pumping facilities

Existing City practice is to charge an impact fee for installation of new wells, large diameter mains, and associated facilities, and to assess a meter installation charge.

Reclamation and dual plumbing requirements

The reuse of wastewater or reclaimed water for purposes such as landscape watering is beneficial because it reduces the demands on available surface and ground waters, and may delay or eliminate the need to expand potable water supply and treatment facilities. Potential applications for reclaimed water include other industrial and cooling uses, toilet flushing, landscape irrigation, agricultural irrigation, fire protection, and aesthetic uses such as fountains.

> Gray water is domestic wastewater composed of washwater from kitchen sinks, bathroom sinks and tubs, clothes washers, and laundry tubs
>
> (USEPA, 1989)

New developments might be required to install dual piping and connections to allow for reclaimed water or grey water landscape irrigation in public and common areas including schools, parks, golf courses, office buildings, and in water features such as decorative pools, fountains, ponds, and other aesthetic features that can be considered for secondary or tertiary water use. EBMUD has recently reached agreement with an office building developer in downtown Oakland for installation of reclaimed water plumbing to be used for toilet flushing. The City of Davis uses storm runoff and secondary-treated effluent to irrigation wetlands habitat. The City of Lincoln uses reclaimed water for golf course and park irrigation.

Developers might also fund construction of in-city wastewater treatment plants to be used for reclaimed water supply. Developers might be required to use reclaimed water for construction and dust control uses.

Building Code and Landscaping Requirements

Developments planned to minimize water use will arise from comprehensive, multi- faceted land use plans emphasizing density and infill development, water efficient landscaping, and open space planning. Regulations can be developed governing landscape standards and plan review, prohibitions on water waste, and plan review of commercial, industrial and recreational landscaping. Retaining large shade trees on newly developed land will reduce water use during the period when new landscaping is being established.

Developers might be compelled through building codes to provide only water-efficient fixtures, insulated pipes and water heaters, and appliances such as ultra-low-flow toilets, showerheads, and point-of-use water heaters. Long uninsulated pipe runs lead to letting showers run to warm up. A 5 gallon-per-minute showerhead run for three minutes will thus waste up to15 gallons per day per person, and energy costs are also significant[72]. Such losses can be reduced or eliminated through short pipe runs, insulated piping, hot water circulation systems, and point-of-use water heaters. Since January 1, 1994, all toilets installed in the state must use no more than an average of 1.6 gallons per flush.

In addition to enforceable codes and policy, incentives to install other water saving devices such high-efficiency clothes washers and other water-using appliances can be provided. Currently, the City of Davis is participating in a cash rebate program in association with the CALFED Water Use Efficiency Program and Pacific Gas & Electric (PG&E) to provide incentives to the public for purchasing water and energy efficient appliances. The City of Lincoln has a similar incentive plan. Incentives might be provided to developers and homeowners to install low- or zero-water use xeriscaping involving a comprehensive low-maintenance approach incorporating planning and design, soil analysis, appropriate plant selection, practical turf areas, efficient irrigation, and use of mulches. EBMUD provides connection fee discounts to customers who install landscapes that no longer require irrigation within three years of installation.

City of Manteca

The City of Manteca has a population of 55,000 and approximately 15,000 connections using about 12,000 acre-feet per year supplied from sixteen wells. The entire city is metered. To offset localized groundwater overdraft, Manteca is participating in the South County Surface Water Supply Project, which will be paid for by two fees charged to developers. Connection fees are composed of a surface water fee, a water meter installation fee, and a water capacity charge. The City has a three-tiered rate structure tied to metered use. Manteca's wastewater treatment plant provides secondary-treated water for irrigation to approximately 300 acres of land. Planned treatment expansion and upgrades will expand City water reclamation. Dual plumbing requirements are being considered

(Keith Canarroe, City of Manteca)

Summary

As a result of studying various urban water management plans, several potential mitigations can be proposed for new developments in the City of Lodi. In summary, these mitigations are:

- Water use efficiency programs and metering
  - Meter water usage and charge by volume
  - Submetering of apartments, condominiums, and trailer parks
  - Establishing an inclining block rate structure
  - Require automatic irrigation systems in new development
  - Charge developer a water meter installation fee

[72] Raising the temperature of 15 gallons of water by 50 degrees requires 6240 BTUs or 1.8 kWh

- Provide detailed and educational billing statements
- Fund water meter retrofit programs for older homes

- Funding and construction of water supply infrastructure
  - Charge a connection charge tied to the cost of the existing supply and distribution system
  - Charge fees that cover new water production and transmission facilities and infrastructure including surface water fee tied to the cost of acquiring and developing the new supply, or alternately, require developer construction of such facilities that serve a single development or limited geographic area
- Reclamation and dual plumbing requirements
  - Require dual distribution systems with dual connections to allow for reclaimed water landscape irrigation in public and common areas
  - Provide incentives for reclaimed water or grey water landscaping at private facilities
  - Require funding of in-city wastewater treatment plants to be used for reclaimed water supply
  - Require use of reclaimed water for construction and dust control uses
- Building code and landscaping requirements
  - Require automatic irrigation systems for new single-family homes
  - Provide incentives for drought-tolerant landscaping
  - Require the installation of low-flow water user fixtures in residential and commercial developments
  - Provide incentives for water-efficient appliances
  - Provide incentives for xeriscape landscaping

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